REPORT OF HYDROGEOLOGIC INVESTIGATION AND GROUNDWATER EVALUATION ORTHO-CHEVRON CHEMICAL COMPANY PLANT MARYLAND HEIGHTS, MISSOURI

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REPORT OF HYDROGEOLOGIC INVESTIGATION
AND GROUNDWATER EVALUATION
ORTHO-CHEVRON CHEMICAL COMPANY PLANT
MARYLAND HEIGHTS, MISSOURI

Dear Don:

We are pleased to enclose this report of our hydrogeologic investigation and groundwater evaluation at the Ortho-Chevron Chemical Company plant in Maryland Heights, Missouri. This assessment of site conditions was performed in general accordance with our proposal to you dated January 16, 1981.

We have presented a discussion of our findings in this assessment including the concentration levels of constituents encountered in samples of soil and groundwater. We recommend additional analyses to confirm and extend these findings.

Please contact us with your comments regarding our investigation and this report.

Very truly yours,

J. D. Campbell, P. E.
Vice President

Donald M. Duncan, P. E.
Vice President

JDC:DMD:baf

enc.

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ACKNOWLEDGMENTS

The preparation of this report and the field work reported herein are due largely to the efforts of the following Woodward-Clyde Consultants personnel: Mr. Philip Knotts (Project Engineer), Mr. William Prosser (Project Geologist), Mr. Peter Barrett (Staff Geologist), and Mr. Charles Huber (Laboratory Technician) with the support of Woodward-Clyde Consultants staff under the technical direction and supervision of Dr. J. D. Campbell (Project Manager). Technical advice and peer review for this project has been provided by Mr. Joseph Kolmer (Senior Project Engineer, Plymouth Meeting).

The authors wish to acknowledge the professional services of Wilson Laboratories, Salina, Kansas, and in particular Ms. Janis Butler (Laboratory Director), Mr. Robert Meyer (Chief Chemist), and Mr. Cliff Baker (Organic Chemist). Portions of their analytical reports have been incorporated by the authors in this report.

We acknowledge and appreciate the support and direction provided by Chevron Chemical Company's project management. Mr. R. Macauley initiated the project and provided Chevron's review of this report. Mr. Don Searle, the current Project Manager, has provided the recent coordination of this work. We appreciate the information and assistance provided by the Ortho-Chevron staff at the facility including Mr. Stan Kanes, Plant Manager, and Mr. Mike Coan and Mr. Dan Holman.

SUMMARY

Thirty-four soil borings were drilled during the field investigation conducted at the Ortho-Chevron Company Plant in Maryland Heights, Missouri. Borings were logged and soil samples were obtained at selected depths for engineering index testing and chemical analyses. The general subsurface profile consists of up to 8 feet of fill at the surface overlying 15 to 20 feet of stiff, brown, silty clay (loess). Underlying the loess is approximately 5 feet of highly plastic residual clay and beneath the clay is shale. The thickness of the shale is quite variable and in some places the shale is completely weathered to clay. Limestone was encountered beneath the shale and at depths ranging from approximately 30 to 70 feet.

Fifteen of the soil borings were completed as groundwater observation wells. Groundwater levels were monitored and groundwater samples were obtained for chemical analyses. The depth to groundwater varied from approximately 2 feet on the east side of the plant to approximately 10 feet on the west. The general direction of groundwater flow is to the west-northwest with an average gradient of approximately 0.021 foot per foot.

Two soil samples which appeared to be contaminated were analyzed for arsenic and organic pesticides. The analytical results presented in Tables 7, 9, and 10 indicate significant concentrations of arsenic and organic pesticides were detected in these soil samples. Near-surface soils which contain arsenic and organic pesticides may distribute these constituents to the environment through surface run-off, wind erosion or

leaching into the groundwater. A soil survey has been recommended to identify those areas of the site where arsenic and pesticides are present and to measure the concentrations in the soil.

Samples from the sediments and soil beneath the storm water retention pond and one composite soil sample obtained from the soil-debris waste pile were submitted to the laboratory for EP toxicity testing. The test results are presented in Table 11 and indicate that these materials do not exhibit the characteristics of a hazardous waste as defined by EP toxicity. These materials may still be classified as hazardous wastes if they are contaminated by an EPA listed hazardous waste and intended for disposal. Further review of these materials to establish a hazardous/non-hazardous classification has been recommended. Precautions should be taken when handling and disposing of these materials.

The analytical results for the groundwater samples obtained from fourteen wells are presented in Appendix F. The distribution of the various groundwater constituents as measured in each well around the site are presented in Figures 8 through 36. The test results indicate that the concentrations of chemical constituents in the groundwater entering the site from upgradient are relatively low and that the area with the highest measured pesticide concentrations is in the centrally located processing and handling area, in the vicinity of wells OWC-6, 7, 8, 10 and 11. The lack of continuity of measured concentrations between wells appears to indicate the presence of isolated individual contaminant sources. Table 12 presents the analytical results for the

organic constituents and selected inorganic constituents measured in each well and for comparison EPA drinking water standards and Missouri groundwater recharge standards.

The mass flow rate of groundwater through the area near OWC-6, 7, 8, 10 and 11 has been estimated at approximately 600 gallons per day to the west-northwest. The estimated potential distance the groundwater could travel in twenty-five years may be 500 to 1000 feet.

These estimates of groundwater flow are based on (1) average site conditions as estimated from the information obtained during this investigation, and (2) the assumption that the average conditions are uniformly representative across the site. The actual conditions at any location on the site will vary from the estimated average conditions, and we expect that our estimates will change as additional information about the site conditions becomes available. Using the maximum permeability measured during this investigation, the distance traveled by the groundwater would be increased by a factor of three (i.e., 1500 to 3000 feet).

The actual distance traveled by groundwater contaminants is expected to be mitigated by soil sorption. Silty clay soils have a high affinity for organic compounds. Because of the low solubility of organic pesticides in water and the estimated slow rate of groundwater movement, organics from any potential recent sources are likely to be contained in the general vicinity of the source.

The contaminant flux or the mass flow rate of contaminants in the groundwater was estimated by two methods:

1. The concentrations of all the organic pesticides detected in

wells OWC-6, 7, 8, 10 and 11 were summed and an average concentration was calculated. The contaminant flux using this average concentration is estimated to be less than approximately 1 gram per day.

2. The concentrations of total organic carbon in wells OWC-6, 7, 8, 10 and 11 were averaged since total organic carbon would include the organic pesticides, organic carrier materials, and miscellaneous organics in the groundwater. On this basis the contaminant flux is estimated to be less than approximately 100 grams per day.

These estimates of contaminant flux are based on the groundwater flow estimates discussed above and the average concentrations of pesticides and total organic carbon from a limited number of groundwater samples. We expect our estimates of contaminant flux will change as additional information about the actual site conditions becomes available. The installation of additional wells, additional sampling and chemical analyses including permeability testing could indicate anomalies at the site, which would significantly affect our estimate of groundwater flow and contaminant flux.

Based on the analyses of the groundwater samples obtained from the monitoring wells installed to date, it appears that the migration of organic and arsenic compounds may still be contained on site. However, the installation of additional wells along the north property line is recommended to better monitor flow across this boundary.

While precautions have been taken to obtain representative groundwater samples, this site assessment is nonetheless based on the analyses

of a single set of groundwater samples obtained at one point in time. The recommendations presented include the installation of four additional wells and additional sets of groundwater analyses to confirm the evaluation of groundwater conditions presented in this report.

Recommendations have been presented for the development of a remedial action program to remove or contain sources of continued contamination present on site. Such a program would be designed based on the results of the proposed soil survey and groundwater studies.

INTRODUCTION AND SCOPE OF WORK

This report presents the results of our groundwater evaluation and hydrogeologic investigation conducted at the Ortho-Chevron Chemical Company Plant in Maryland Heights, Missouri. The field work was conducted from January 19 to February 27, 1981, as authorized by the Chevron Chemical Company, Mr. R. B. Macauley, Project Manager, and by letter from Mr. S. H. Kanes dated January 19, 1981. The purposes of this investigation were to:

1. Evaluate the potential contamination of the soil and groundwater as a result of past production activities and on-site disposal of waste materials;

2. Evaluate the potential magnitude and extent of contaminant migration;

3. Select samples for analysis and classification as hazardous waste materials; and

4. Assess site conditions with respect to government regulations and recommended water quality criteria.

Existing geological information was reviewed prior to the field investigation. During the field investigation, borings were drilled at thirty-four locations on the site to obtain soil samples which were retained for engineering classification and, if required, chemical analyses. Six boring locations were added during the field investigation to the proposed boring locations at the request of Chevron. Soil samples were also obtained at Chevron's request from a soil-debris waste pile on site. Fifteen of the soil borings were completed as groundwater observation

wells including three sets of nested wells. The nested wells consist of two separate wells, installed at approximately the same location, with the screened portion of the wells installed over different depths within the same aquifer or installed in two separate aquifers or geologic formations. Field permeability tests were conducted in selected wells, water levels were monitored, and groundwater samples were obtained for chemical analyses.

The evaluation and management of surface water at the site and recommendations on design of remedial work for the control of contaminated groundwater including additional groundwater monitoring was outside the scope of this project. If such work were required, we would be prepared to assist Chevron with the design and implementation of remedial works, continuation of groundwater monitoring, personnel training, reviews with regulatory groups, and additional site evaluations as appropriate.

SITE DESCRIPTION

The Ortho-Chevron Chemical Company Plant is located along Adie Road in Maryland Heights, Missouri, as shown in Figure 1. A general site plan showing the layout of the plant is presented in Figure 2. Surface elevations at the site vary from a high of approximately 540 at the east side of the site to elevation 510 at the west. Surface drainage is generally to the west/northwest and a well-defined but intermittent drainage way flows from south to north near the west end of the site. The plant site is located in a drainage basin which is a tributary to Fee Fee Creek which in turn is a tributary to the Missouri River.

We understand that production processes at the plant are generally limited to formulating and packaging organic pesticides. Raw materials and finished goods are shipped to and from the site by rail and truck. Plant facilities include office buildings, a shower and lunchroom building, storage tanks, and two series of production buildings along two rail spurs. A small storm water retention pond is located near the northwest corner of the site.

The Ortho-Chevron Chemical Company has been operating at this site for approximately twenty-five years. Based on our previous geotechnical investigations at this site and conversations with plant personnel, we understand that leaks and spills of pesticides and carrier products have occurred in the past. We also understand that past practice may have included on-site disposal of certain waste materials, including the burial of debris from a previous fire. Several of the borings added during the field investigation were intended to investigate potential locations of buried materials.

The plant is located in an established industrial area. Immediately southeast and topographically and hydraulically upgradient from the plant is an abandoned brick-clay mine, see Figure 1. Until recently the abandoned mine was used as a St. Louis County sanitary landfill. The landfill is now closed and has a soil cover; however, the cover appears thin and vegetative cover is minimal. Air photographs taken in 1961 indicate a mined area of approximately 27 acres. We were not able to determine the acreage and depth of the mine at the time it was abandoned

and landfilling began. The landfill is a potentially large groundwater recharge source and may contribute to the high groundwater levels encountered at the Ortho-Chevron Plant site. Odors of gas escaping from the landfill can be detected adjacent to the landfill, especially on warm days. It is not known if any monitoring wells exist at the landfill. Groundwater monitoring wells were not observed along the perimeter of the landfill.

Immediately east and also topographically and hydraulically upgradient of the Ortho-Chevron Plant is a long established fertilizer plant, see Figure 1. Various other small industrial and commercial operations are located in the general area of the plant.

A field survey was made last fall by Mr. William Prosser (WCC) to determine if shallow water supply wells are in use within the general vicinity of the plant. A search was made of the Missouri Geological Survey records and personal interviews were conducted with people working or residing within one-fourth mile of the plant. A total of six wells were located in Sections 23 and 26 T.46N, R.5E. None of the wells identified is within one-fourth mile of the plant site. The wells vary in depth from 140 feet to 325 feet and penetrate through the Ste. Genevieve Limestone into the St. Louis Limestone formation and in some cases into the Spergen Formation. The available details for each well are summarized in Table 1.

FIELD INVESTIGATION

Exploratory Borings

Thirty-four borings were drilled at locations shown on the site plan, Figure 2. The borings were advanced to depths of up to 69.5 feet

using a truck-mounted 8-inch-diameter continuous-flight auger drill rig. Soil samples were obtained at selected depths by hydraulically pushing a 2-inch-I.D. liner-tube sampling device. Samples of the rock encountered at the site were obtained from borings OWC-2 and OWC-12 using an NX-sized double-tube core barrel. The borings were located in the field based upon the topographic map provided by Ortho-Chevron and were drilled under the supervision of Woodward-Clyde Consultants' geologist or engineer. Grade elevations at the boring locations were surveyed by Woodward-Clyde Consultants using the established bench marks located on the site. Elevations of ground surface and changes in soil strata are rounded to the nearest foot.

During the field investigation, 233 soil samples (approximately seven samples per boring) were obtained. The samples were returned to our office and extruded at the end of the day or, when requested, the samples were extruded in the field for viewing by Ortho-Chevron personnel. Once extruded, the samples were placed in glass jars which had been previously rinsed with an organic solvent (acetone) to prevent outside contamination. In the event that future examination of the samples is required, samples obtained at depths of less than 20 feet are currently stored under refrigeration at our office in St. Louis. Samples obtained at depths greater than 20 feet and samples selected for chemical analyses were shipped on ice to Wilson Laboratories in Salina, Kansas, where they are also stored under refrigeration. All samples will be refrigerated and stored until our services are terminated, after which they will be relinquished to Ortho-Chevron.

Logs of the borings were prepared based upon observations of the auger cuttings, drilling characteristics, and recovered samples. The logs were subsequently modified, as necessary, based on the laboratory test results. The detailed boring logs are presented in Appendix A. Borings not completed as wells were pumped full with a cement-bentonite grout.

Observation Well Installations

Fifteen groundwater observation wells were installed at the locations shown on the site plan, Figure 2. The wells range in depth from 17 feet to 69.5 feet in depth. Details of the individual well installations are summarized in Table 2. Individual well profiles are presented in Appendix B.

Borings to be completed as observation wells were advanced with an 8-inch-diameter continuous-flight auger to the selected well depth. While the boring was being drilled, the slotted PVC well screen sections and the solid PVC riser pipe sections were cemented together. A PVC cap was also cemented to the bottom of the well screen. The pipe was then hoisted by the drill rig and lowered into the boring immediately after the augers had been removed. A well-graded washed river sand was poured into the annular space around the well screen to sufficiently fill the annular space around the screen to a depth of approximately 2 feet above the top of the screen. Bentonite clay pellets were poured into the annular space to form a 3-foot-thick clay seal above the sand. A cement-bentonite grout was pumped into the annular space from the top of a bentonite-pellet seal to within approximately 2 feet of the surface. Concrete was added to the remaining annular space and a 6-inch-diameter

steel pipe was placed over the well and set into the concrete. The concrete acts to hold the steel protective casing in place and acts as a surface water seal. Each well has a vented PVC cap. Each protective casing is provided with a drain hole drilled approximately 4 inches above the existing grade.

A 1/4-inch-thick 2-inch-wide steel bar was inserted into slots on either side of the protective casing and padlocked into place to prevent unauthorized entry to the wells. One key will open all the locks and sets of keys were left with Mr. Coan and Mr. Holman at the Ortho-Chevron Plant. The protective casings were painted either yellow or black at the discretion of Ortho-Chevron personnel. The appropriate alpha-numeric well identification was stenciled on each protective casing in the contrasting color. The wells can be further identified by the press-apply number glued on each well cap.

Development of Observation Wells

Each well was bailed several times in order to develop the well prior to sampling. The wells were developed to minimize the effects of drilling on the quantity and quality of groundwater recharging the well. The actual number of times each well was bailed prior to sampling is presented in the well summary table, Table 3. The recharge to these wells was relatively slow and each well was bailed essentially dry during development. All wells were drilled without the aid of drilling fluid with the following exceptions:

1. OWC-2 and OWC-12 were drilled into the limestone and potable water was pumped into the borings to remove the cuttings and to cool the core barrel; the water was not recirculated;

2. Potable water was used to flush the borings for wells OWC-6 and OWC-8 because the borings caved before the well screen could be set.

Precautions were taken to prevent introducing contaminated material into the wells and to prevent cross-contamination of the wells. As an added precaution, an individual bailer was installed in each 4-inch-diameter observation well. The bailers were initially constructed and cleaned in our laboratory and individually sealed in plastic and transferred to the site. A bailer was hung from the cap in each well and that was the only bailer used to develop and sample that well.

The bailers hanging in the wells are approximately 4 feet long and have an inner diameter of 2.5 inches. Each bailer has a capacity of approximately one gallon.

Well OWC-2 has a 1.5-inch-diameter casing which extends to a depth of 69.5 feet. This well has 10 feet of screen, 8 feet of which extends into a massive unweathered limestone, and 2 feet extending into the shale immediately above the limestone. We were able to bail this well essentially dry with a 4-foot-long 3/4-inch-O.D. PVC bailer. Recharge to the well was extremely slow and the water was very muddy. In our opinion, the recharge was primarily drilling fluid and not representative of the groundwater. For this reason, OWC-2 was not sampled for chemical analyses.

OWC-12 also has a 1.5-inch-diameter casing which extends 8 feet into limestone. However, at this location the limestone appears to be weathered. Clay seams were observed within the recovered rock core. The 2 feet of screen which extends above the limestone is in clay rather than shale at this site. Using a bailer similar to the one used in OWC-2, we were unable to bail this well dry because of the faster rate of recharge. Groundwater samples were obtained from this well for chemical analyses.

Groundwater Sample Collection

As recommended by the Missouri Department of Natural Resources (1979), in preparation for sampling, each well was flushed, i.e., bailed dry or a volume of water equivalent to a minimum of three times the casing volume was removed, and the well allowed to recharge prior to sampling. To evaluate the hydraulic gradient of the groundwater, the depth to groundwater was measured in each well prior to flushing and sampling. At the time of sampling the following water quality parameters were measured in the field: pH, specific conductivity, and temperature. The results of these field tests are presented in Table 4.

The following samples were obtained from each of the fourteen wells sampled. One small glass vial for total organic carbon (TOC), three one-liter glass bottles for organic analyses, one plastic quart container for metals analyses and one plastic quart container for general water quality analyses.

At each well the bailer was carefully lowered into the water to minimize agitation of the water column. The bailer was withdrawn from

the well and a small quantity of water was used to rinse the TOC vial and the vial was then filled. A large-mouth plastic bottle used for the field analyses was rinsed and filled. The remaining water in the bailer was used to rinse the three glass bottles and the two plastic containers. The second bailer of water was then drawn and an approximately equal aliquot of water was poured into each sample bottle. This procedure continued until each bottle was completely full. The samples were then immediately placed on ice.

Immediately after the samples were collected, they were returned to our laboratory and the samples collected for metals analyses were filtered through individual 0.45-micron pore-size filters and poured into acid washed, acid preserved, plastic containers in preparation for shipment to the water chemistry laboratory. All samples were then shipped on ice to Wilson Laboratories in Salina, Kansas for analyses. The samples used for organic analyses were filtered through 1.0 micron pore-size glass fiber filters at Wilson Laboratories prior to analyses. The purpose of filtering the samples is to remove suspended solids which if digested or extracted with the sample would contribute non-representative amounts of certain constituents to the groundwater sample. Dissolved solids, not suspended solids, are normally transported by groundwater.

GEOLOGIC SETTING

The Ortho-Chevron Plant is located on an eroded gently sloping upland loessial surface within the Fee Fee Creek watershed. Fill

material was encountered in the borings over a majority of the site. The fill was generally firm to stiff, brown, low plastic, silty clay which may include construction debris and organic soils in localized areas. The fill varied in thickness with up to 8 feet of fill encountered along the north rail spur.

Firm to stiff, brown, low plastic, silty clay loess was encountered across the entire site beneath the fill. Where the fill material was not encountered, the loess was the surficial soil. The loess was generally 10 to 15 feet thick.

Borings drilled in the northeast half of the site and the northwest corner indicated that the uppermost portion of the loess in these areas had been reworked by water, i.e., stream, pond, or swamp deposits. These alluvial deposits varied in thickness up to 15 feet and were generally firm to stiff, dark gray to gray, low density, organic silty clays with numerous root holes and small voids.

Bedrock units beneath the loess consist of Pennsylvanian Age strata of the Pleasanton, Marmonton, and Cherokee groups in descending order. These are primarily shales but may also contain cyclic sequences of sandstone, siltstone, and limestone with occasional seams of clay. The beds generally range in thickness from a few inches to several feet. The total thickness of these shale units observed at the site varied from about 5 feet on the west to about 40 feet on the east. In some locations the shale was not present or was completely weathered to clay. In general, a 5-foot-thick, highly plastic, residual clay layer was encountered between the base of the loess and the uppermost shale unit.

Underlying the shale units is the highly irregular erosional unconformity of the Ste. Genevieve limestone formation of the Mississippian system. The Ste. Genevieve is generally described as dense, massive, and relatively pure limestone.

Subsurface Profile

The generalized subsurface profile described above has been shown in more detail in four cross-sections which include schematic logs of the borings. Our interpretation of the subsurface profile is shown on these cross-sections presented in Figures 3 through 6.

Hydrogeology

The original or natural surficial soils in this area are classified as the Menfro-Winfield Series by the Soil Conservation Service (1972). The Menfro soils are reported to have moderate infiltration rates when thoroughly wetted. These soils are reported to be generally deep, well drained with moderately fine to moderately coarse textures.

The Winfield soils are reported to have slow infiltration rates when thoroughly wetted and consist generally of soils with moderately fine textures. These soils have a slow rate of water transmission.

Because of the low permeability, the loess retards the infiltration of precipitation and Miller et al. (1974) report that most of the annual precipitation is lost as runoff and evapotranspiration. Wells completed in the loess have very small yields.

A search has been made of the Missouri Geological Survey records which indicates no wells are located within one-fourth mile of the plant site and that the nearest wells range in depth from 140 feet to 325 feet and penetrate the limestone, see Table 1 and Figure 1.

Fuller and Knight (1967) report 5 to 10 gallons per minute may be obtained from the limestone at depths of 250 to 400 feet. Groundwater contained in the bedrock in this area is described as very saline, containing more than 1000 milligrams per liter of total dissolved solids. This salinity increases with depth, with 20,000 to 30,000 milligrams per liter TDS common at 2,000 to 3,000 feet (Fuller and Knight, 1967). While bedrock aquifers may yield adequate supplies of water, the water is generally unusable because of its salinity. Public water supplies in the plant site area are taken from surface water sources such as the Missouri and Meramac Rivers (Missouri Department of Health, 1971).

During our investigation groundwater was encountered in the loess at depths ranging from 2 feet below the surface along the east side of the plant to about 10 feet below the surface in the northwest corner. This water was probably perched on the underlying residual clay and shale which would retard further downward movement. Based on the hydrogeologic conditions at the site and the observed groundwater levels, in our opinion, the groundwater was in an unconfined condition and flowing to the west/northwest. Groundwater levels measured in each well during this investigation are listed in Table 5. A groundwater contour map is presented in Figure 7 which was interpreted from the water levels observed on March 19, 1981.

Field Permeability Tests

Field permeability tests (slug test) were performed in wells OWC-6, 7, 8, 9, and 15. These are shallow wells screened in the loess. The in-situ permeability of the soil in the vicinity of the wells was estimated from the rate of rise or recharge of the water level in the wells after a certain volume or "slug" of water was suddenly removed from the well. The data were plotted and the permeabilities were calculated using a methodology developed by Bouwer and Rice, 1976. Estimated permeabilities calculations are presented in Appendix C. The results of the slug tests are presented in Table 6.

The average estimated permeability was 1 foot per day (3×10^{-4} centimeters per second) and the range of test results was from about 0.1 to 3 feet per day (3×10^{-5} to 1×10^{-3} centimeters per second). We expect this average estimated permeability will change as additional permeability tests are performed in other wells at the site. The results from additional tests may indicate the soil is more permeable.

LABORATORY TESTING

Engineering Index Properties

Soil samples representative of the four soil strata (i.e., fill, water-modified loess, loess and residual clay) encountered at the site were selected for general engineering index property testing. For continuity, the samples were selected from the same boring, OWC-5. The subsurface profile at this location was typical for the site. Laboratory tests included visual classification, natural water content, liquid

limit, plastic limit, and grain size distribution. The test results are presented in Appendix D.

Soil Chemistry

Arsenic. The results of selected soil samples analyzed for arsenic are presented in Table 7. Six soil samples from Boring B-219 ranging in depth from 2 feet to 21.5 feet were submitted to Wilson Laboratories for arsenic analysis. Boring 219 was drilled on the north rail spur where in the past hopper cars of arsenic were unloaded with open conveyors. Two soil samples from Boring B-203 at 5 and 10-foot depths were also submitted for arsenic analysis. A soil sample from OWC-10 at a depth of 4 to 5.5 feet and a soil sample from OWC-11 at a depth of 1 to 2.5 feet were also analyzed for arsenic in addition to organic pesticides. The samples were reduced and analyzed for production of arsine gas.

Organic Pesticides. Certain organic pesticide analyses contained in the list in Table 8 were performed on selected soil samples. The results of these analyses are presented in Tables 9 and 10. Soil samples were selected from borings OWC-10 and OWC-11 for analyses of organic pesticides. In order to provide some indication of the maximum concentrations which might be expected at the site, we initially selected and analyzed samples which we suspected to be most contaminated. Borings OWC-10 and OWC-11 were drilled at locations with high potential for contamination and the samples selected (one from each boring) had an organic odor.

The samples were submitted to Wilson Laboratories where they were prepared and analyzed.

The results of the organo-chlorine pesticides analysis for the sample taken from OWC-10 at a depth of 4 to 5.5 feet are presented in

Table 9. The results for the organo-chlorine pesticides analysis for the sample taken from OWC-11 at a depth of 1 to 2.5 feet are presented in Table 10. The laboratory reported Kelthane did not elute properly from the gas chromatagraph and could not be analyzed in the samples. The samples were also analyzed for arsenic and the results are shown on the respective tables.

Extraction Procedure Toxicity. Three samples were submitted to the laboratory for EP toxicity chemical analyses. The results of these analyses are presented in Table 11 and in Appendix E. One composite sample was taken from the soil, rock, and construction debris waste pile and the other two samples were taken from Boring B-212 in the natural soil and sediments from the storm water surface impoundment (pond).

The waste pile sample was a representative sample composited from samples obtained from four hand-augered holes approximately 3 feet deep and one 4-foot deep test pit. Attempts were made to auger deeper at several locations; they were unsuccessful because of the rocks and debris in the pile. The waste material sampled in the waste pile passed the EP toxicity test and is not classified hazardous based on that method. Consideration should be given to hazardous classifications resulting from listing of specific wastes or processes.

The storm water retention pond was empty at the time of our investigation, but because of the soft bottom sediments a ramp was built out into the pond to permit sampling. The ramp was about 3 feet thick; sampling was started at 3 feet. Samples were collected at 3.0 to 4.5 feet, 5.0 to 6.5 feet, 7.0 to 8.5 feet and at selected depths down to 21.5 feet

below the top of the ramp. The samples at 3 feet and 7 feet were selected for EP toxicity analyses. The sample at 3 feet was representative of the near-surface pond sediments. The sample at 7 feet was from the soil immediately below the sediments. Both samples passed the EP toxicity test; however, if the soil or sediments are intended for disposal and have been contaminated with a listed hazardous waste, they may be defined as a hazardous waste and may be subject to the hazardous waste management regulations.

Groundwater Chemistry

Groundwater samples collected from fourteen observation wells were analyzed by Wilson Laboratories for organics, metals, total organic carbon, and general water quality parameters. Well OWC-2 was not sampled because the well did not recharge sufficiently to allow proper development; the water it contained was not considered representative groundwater. The distribution of each major parameter analyzed in the groundwater is presented in Figures 8 to 36. The complete results of water quality analyses performed on this set of groundwater samples are presented in Appendix F. Results of the organic analyses and selected inorganic analyses are summarized in Table 12. EPA drinking water standards and Missouri groundwater recharge standards are shown for comparison.

The groundwater samples were analyzed for the organic compounds shown in Table 8 with the exception of Kelthane, Trithion, and Sevin. The samples could not be analyzed for Kelthane because Kelthane did not elute properly from the gas chromatagraph. A standard for Trithion analysis was ordered by Wilson Laboratories but was not received in time

to analyze the samples. Unidentified peaks were not observed in the analyses of the organo-phosphorous pesticides which would indicate that Trithion was not present. See Appendix G for a discussion of the laboratory analyses.

It was anticipated that Sevin could be analyzed with the organo-phosphorous pesticides on a nitrogen-phosphorous gas chromatagraph detector. However, analyses of the samples indicated that interferences were present which precluded the use of the nitrogen-phosphorous detector. The samples were then analyzed with a highly selective flame photometric detector operated in the phosphorous mode. Six phosphorous containing compounds were detected but the laboratory was unable to detect Sevin because the detector was not sensitive to nitrogen-containing compounds.

DISCUSSION OF RESULTS

Significant concentrations of arsenic and organic pesticides were identified in certain near-surface samples of soil and in groundwater samples obtained from observation wells located within and downgradient from the central plant processing area. Groundwater is considered to be the primary transport mechanism for potential movement of these contaminants across and off the site. Where high concentrations of arsenic or pesticides exist in uncovered near-surface soils, additional transport mechanisms exist including: (1) erosion and surface runoff in storm water, (2) wind erosion, and (3) leaching of the affected soil by infiltration of precipitation.

This initial assessment of site conditions has focused primarily on potential contamination and contaminant movement within the groundwater regime. Selected soil samples were analyzed to evaluate hazardous waste characteristics by EP Toxicity and total extractions were performed on other suspected contaminated soil samples to determine the levels and presence of various pesticides. Results of the specific findings are discussed below and recommendations are presented to survey the potential sources of contamination on site.

Following a survey of the sources of contamination, recommendations have been provided for the development of a program to remove or contain the identified sources.

Soil Contamination

Arsenic. A railroad unloading facility consisting of an open conveyor for bulk transport of arsenic was previously operated near the location of boring B-219 on the north side of the plant site. Soil samples obtained from boring B-219 were found to contain arsenic at the concentrations shown in Table 7. Arsenic concentrations decreased sharply with depth in Boring 219 from 480 ppm at 2 feet to approximately 3 to 6 ppm below 10 feet. Boring 219 was not completed as an observation well to eliminate the risk of providing a direct route to the groundwater in the event of spills or leaks from railroad cars parked on the tracks.

The background levels of arsenic in the loess soils are unknown at this time. Soil samples obtained at two depths in boring B-203 which was drilled near the southwest corner of the site indicate total arsenic

concentrations of approximately 5 ppm which is similar to the concentrations at depths below 10 feet at the unloading facility. However, groundwater and wind transport of arsenic may have affected the arsenic content of soils in the plant vicinity. Soils from natural parent materials may have background arsenic levels approximately 1000 times less than the 5 ppm of arsenic found in soils at depth at this site. Additional samples of similar loess soils from off the site may be analyzed to confirm background levels.

Boring OWC-11 was drilled in an area which is now paved with asphalt to the west and downgradient from the arsenic processing facility. One soil sample obtained at a depth from 1 to 2.5 feet below the asphalt was selected for analysis of organic pesticides and arsenic. The appearance and odor of the sample indicated that this was potentially one of the more contaminated locations encountered at the site. The total arsenic in the sample was analyzed at 570 ppm, similar to the 480 ppm at 2 feet in Boring 219. The arsenic concentration in the groundwater sample obtained from well OWC-11 was measured at 0.11 mg/l.

A single soil sample from a depth of 4 to 5.5 feet was also analyzed from Boring OWC-10 located in the central processing area of the plant near where leaks in an underground pipeline were reported. This sample was analyzed for organic pesticides and arsenic. The concentration of arsenic in the soil was 5.5 ppm. The arsenic concentration in the groundwater sample obtained from well OWC-10 was measured at .006 mg/l.

Waste soils generated on site during construction activities should be evaluated to determine if they are considered hazardous wastes as a

result of arsenic or other pesticide contamination. The EP Toxicity test as one indicator of hazardous waste does not typically extract the total constituents from a sample and there is a dilution effect of the extract. Direct comparisons cannot be made between the total concentrations of arsenic or pesticides in the soil samples and the concentrations in the extract of the EP Toxicity analyses. Regardless of the EP Toxicity analyses, waste soils may be considered a hazardous waste if they are contaminated by specific pesticides listed by EPA.

There are no known regulations or standards for allowable limits of arsenic or other pesticides in soils which are not considered a waste material. However, significant concentrations of arsenic in near-surface soils are likely to migrate into the environment. A survey of near-surface soils is recommended to define sources of contamination so that effective containment procedures can be developed. The formulation procedures used in preparing arsenic pesticides should be determined. If arseno-organic formulations were prepared, the arsenic may be in a more soluble form than if it was prepared in a dust form.

Organic Pesticides. Two soil samples, one each from Borings OWC-10 and OWC-11, which were suspected to be contaminated were submitted to the laboratory for organic pesticide analyses. The test results are presented in Tables 9 and 10. As per Ortho-Chevron's instructions, when relatively high concentrations or organo-chlorine pesticides were encountered, analyses for the remaining organic pesticides were discontinued. With the exception of the hazardous waste management regulations (RCRA),

there are no known regulations or standards for acceptable levels of pesticides in soils which are not considered waste materials.

As was recommended for evaluation of arsenic concentrations, a survey of near surface soils should include analysis for organic pesticides. Composite samples may be considered as a screening mechanism to reduce the cost of laboratory analyses. Analyses should include all persistent pesticide compounds that might reasonably be expected to be present in the soils on site.

Remedial work required to remove, cover or isolate sources of contamination may be developed following the soil survey. Soils intended for disposal which are known to be contaminated by specific listed pesticides are considered hazardous wastes and are subject to the hazardous waste management regulations. Details of these requirements are contained in pages 33120 to 33127 of the Federal Register, Volume 45, No. 98, dated Monday, May 19, 1980, and as amended November 12, 19, and 25, 1980.

Extraction Procedure Toxicity. Three soil samples were submitted to Wilson Laboratories for EP toxicity testing. One representative composite sample was obtained from the soil, rock and construction debris waste pile on site; two representative soil samples were obtained from the storm water retention pond. In the storm water retention pond one sample was obtained from the near-surface bottom sediments. A second sample was taken from the soil just below the bottom sediments (approximately 4 feet below the pond bottom).

The test results for the EP toxicity analyses are presented in Table 11. The results indicate that the soils are not hazardous as defined by the EP toxicity test.

The concentration in the soil of other organic pesticides which are not analyzed in the EP toxicity test may be relatively high and may be determined by additional chemical analyses. Precautions should be taken when handling or disposing of this material.

Groundwater Contamination

Groundwater samples from fourteen observation wells were analyzed for organic pesticides, total organic carbon, metals, and general water quality parameters listed in Table 8. The analytical results for each well are presented in Appendix F. The general lack of apparent continuity of detectable organic pesticides between wells indicates that isolated, individual sources of contamination exist rather than a single source. Distributions of the organic pesticides, metals, TOC, and selected water quality parameters, as measured in each well, are presented in Figures 8 to 36. The following organic pesticide compounds were analyzed for and were not detected in any of the groundwater samples:

Chlordane
Chlorobenzilate
Toxaphene
Captan
Methoxychlor
Difolatan
Guthion

The analytical results for the groundwater samples obtained in the upgradient wells OWC-1 and OWC-9 indicate that the groundwater entering the site was relatively uncontaminated by materials which were handled on the plant site; however, low concentrations of Aldrin, Lindane, and 2,4-D were present in the sample from OWC-1 and low concentrations of DDE, DDT, Aldrin, Dieldrin, and Lindane were present in the sample obtained from OWC-9.

Well OWC-3 also appears to be relatively uncontaminated. Lindane and 2,4,5-T at low concentrations were present in the sample. Leaks and spills from the truck and rail traffic in the immediate vicinities of wells OWC-1, 9 and 3 may represent a potential source of contaminants. Wind-borne particulates may also be a contributing factor, particularly where material may have been stored or incinerated in this area.

At this time there appears to be no apparent influence on the groundwater entering the site due to the sanitary landfill and fertilizer plant, both of which are upgradient from this site. The concentrations of the general water quality parameters which would indicate outside influences were relatively low. We were not able to locate representative background water quality data from any similar local wells completed in the loess. No known local water supply wells have been completed in the loess because of the low transmissibilities.

In general, the water quality is hard to very hard with relatively high dissolved solids which could make it unsuitable for use as a potable water supply or for certain industrial processes. The groundwater

has a relatively high concentration of manganese which has no apparent toxic properties at this concentration but it may cause stains and deposits on fixtures. The water is also slightly corrosive to corrosive and may cause attack on metal piping. Installation of subsurface piping should include a corrosion protection system.

Wells OWC-3 and 4 are located along Adie Road. Surface runoff contained in the ditch on Adie Road is a potential source of groundwater recharge. During our investigation it was noted that the drainage in this ditch was very poor and that the water had a tendency to pond in the vicinity of well OWC-4. The higher chloride concentrations in wells OWC-3 and 4 may be the result of salt used to de-ice the roads. We also observed that the pavement runoff in the area of the loading docks on the south side of Buildings B and E drains into the ditch along Adie Road. Leaks and spills on this pavement which were not totally removed may account for some of the Mirex, Heptachlor, Lindane, 2,4-D, and 2,4,5-T observed in OWC-4.

The highest concentrations measured in the groundwater were generally measured in the area of wells OWC-6, 7, 8, 10, and 11. The wells in this central processing and storage area of the plant had the highest frequency of detectable organic pesticide compounds. Based on our observations of the soil samples obtained during the field investigation, results of the soil and groundwater chemical analyses, and discussions with plant personnel, this area was apparently the site of leaks and spills from buried piping and surface handling. In the past this area was potentially used as an on-site disposal area, as evidenced by the

waste materials encountered during the excavation of pier foundations for Building G. We understand that these practices which may have resulted in leakage of products into the ground have been eliminated. Underground piping has been raised above ground or replaced with stainless steel pipe and no new sources of subsurface contamination are expected.

A groundwater sample obtained from OWC-13 located to the west and downgradient from the central processing and storage area contained a relatively high concentration of Lindane as shown in Figure 8. The source of the Lindane is unknown; the source may be fire debris reported to have been buried on site or an old spill or leak in the processing area.

The rock core obtained from boring OWC-12 indicated the limestone in this area was moderately weathered and six 1- to 2-inch-thick clay seams were encountered in the top 4 feet of the rock. After each bailing the recharge to the well was relatively fast and clean. Groundwater samples were obtained for analyses. In our opinion, the shale and residual clay deposits at this site should provide an effective barrier to contaminant movement from the shallow groundwater into the limestone. This was partially confirmed by the poor recharge into well OWC-2 which also penetrates into the limestone. However, a wide variety of organic pesticide compounds were detected in well OWC-12. Potential transport mechanisms for movement of pesticides into the limestone bedrock may include:

1. Piers for building foundations which may penetrate through the

clay into the limestone. Woodward-Clyde Consultants provided field inspection for the piers installed for Building G (WCC report S79-9). The piers for Building G were installed through 15 feet of contaminated fill which included buried waste materials. The thirteen piers were 30 inches in diameter and extended to a depth of approximately 30 feet. Daily field reports indicate the piers are bearing on the limestone. Our soil and foundation report for the Maintenance Shop (S78-55) recommended smaller diameter piers for this building to bear in the residual clay. Information on the foundation conditions of the remaining structures was unavailable.

2. Bore holes from previous soil investigations penetrate into limestone. They may not have been adequately plugged.

3. The residual clay may be discontinuous in the areas of the old north-south stream channel which was observed to have existed between grid lines 600W to 800W on the site plan presented in Figure 2. The residual clay was formed from the parent shale deposits at the site which were exposed to the elements and weathered. Shale is a sedimentary deposit which is generally deposited in horizontal beds. At this site the shale was deposited to at least elevation 525 as encountered in boring OWC-2. The upper portion of the shale was weathered to clay and apparently eroded from the site, potentially by an ancient stream. Near the middle of the site the shale has been eroded down to at least elevation 490 as encountered in Boring 210. The shale in this area is completely weathered to clay which is generally less than 10 feet thick over the limestone. The potential exists that an ancient stream channel may have

completely eroded the clay-shale deposit exposing the limestone over a portion of the site. Finally the wind-blown silty clay (loess) was deposited over the weathered eroded shale deposit resulting in the geologic profile encountered at the site.

4. The residual clay and shale may have a macro-structure (joints or desiccation crack remnants) that permits seepage.

The groundwater samples obtained from the downgradient wells OWC-14 and 15 were relatively uncontaminated, indicating the effects of groundwater recharge from the storm water retention pond appear to be relatively insignificant. Low concentrations of Aldrin, Dieldrin, and Lindane were detected in OWC-14. Only Dieldrin and Lindane at very low concentrations were detected in OWC-15.

The complete analytical results for each well are presented in Appendix F. Table 12 presents the results of the organic analyses and selected inorganic analyses for each well and, for comparison, EPA drinking water standards and Missouri groundwater recharge standards.

Potential Waste Migration

Figure 7 shows the groundwater contour map interpreted from groundwater levels observed during the period of this study. Water levels indicate the general direction of flow to the west-northwest with an average gradient across the site of approximately 0.021 foot per foot. The average permeability of the soil is estimated at less than 1 foot per day based on the field permeability or slug tests performed in selected wells at the site. Assuming a soil porosity of 30 percent, the actual velocity of the pore water is estimated to be much less than

1 foot per day. Assuming these are average conditions, we estimate the groundwater would flow approximately 500 to 1000 feet in twenty-five years toward the west-northwest.

These estimates of groundwater flow are based on (1) average site conditions as estimated from the information obtained during this investigation, and (2) the assumption that the average conditions are uniformly representative across the site. The actual conditions at any location on the site will vary from the estimated average conditions, and we expect that our estimates will change as additional information about the site conditions becomes available. Using the maximum permeability measured during this investigation, the distance traveled by the groundwater would be increased by a factor of three (i.e., 1500 to 3000 feet).

The actual rate and quantity of pesticides and arsenic movement in the groundwater is mitigated by soil attenuation. The silty clay soil at this site has a high affinity for organic pesticides and the rate of groundwater movement is slow enough to allow the soil to sorb some of the pesticides as they flow through the soil. The low solubility of the pesticide compounds also limits the quantity of contaminants which can be dissolved in the groundwater. Finally, the time rate of loading will affect how far the contamination has moved. The more recent loadings have not had time to move very far and, therefore, much of the contamination may be contained in the near vicinity of the source.

The contaminant flux or the mass flow rate of the pesticides including arsenic is a function of the groundwater flow rate, the concentration of

the contaminant and the sorption potential of the soil through which the water flows. Because of the apparent isolated individual sources of contaminants, the concentrations for all detected organic pesticides, in the wells where the higher concentrations were measured (i.e., OWC-6, 7, 8, 10, and 11), were averaged to estimate the potential contaminant loading. Alternatively, since the levels of total organic carbon (TOC) include the organic pesticides in addition to the organic carrier materials and other miscellaneous organics in the groundwater, these values have also been averaged for the same wells and used as another estimate of the potential loading. The average concentration for the organic pesticides detected in the groundwater in the selected area is estimated at 0.16 ppm. The average concentration for total organic carbon is 46 ppm.

Based on our hydrogeologic investigation and assuming a contaminant plume width of approximately 200 feet, the groundwater flow rate is estimated at about 600 gallons per day. Based on the average concentration for the organic pesticides presented above, we estimate the net organic pesticide contaminant loading may be less than about 1 gram per day. Based on the average concentration for TOC presented above, the net contaminant loading may be less than about 100 grams per day.

These estimates of contaminant flux are based on the groundwater flow estimates discussed above and the average concentrations of pesticides and total organic carbon from a limited number of groundwater samples. We expect our estimates of contaminant flux will change as additional information about the actual site conditions becomes available. The installation of additional wells, additional sampling and chemical

analyses including permeability testing could indicate anomalies at the site, which would significantly affect our estimates of groundwater flow and contaminant flux.

RECOMMENDATIONS

Based on our field investigation, laboratory tests, analysis, and prior experience we present the following recommendations for your consideration. We will be pleased to discuss these recommendations with you and to develop a work program to implement these recommendations as you desire.

1. Significant concentrations of arsenic and organic pesticides have been encountered in soil samples obtained on site. We recommend that an additional survey be made of the near-surface soils to identify zones where higher concentrations of arsenic and pesticides are present. The survey may be established in a grid format with samples composited from the upper approximately 1½ feet. Particular attention should be given to expected source areas based upon the results of the contamination distributions in the groundwater. Composite samples made up from several shallow borings may be used as an initial screening program for organic pesticides in order to limit the cost of analyses. Analyses should be made for all persistent pesticide compounds which may be present on the site. Following the evaluation of the analytical results, a remedial action program, if required, could be developed and implemented in cooperation with the EPA.

2. Although every precaution was taken to obtain representative samples of the groundwater, the interpretations, assessments, and evaluation presented in this report are based on a single set of analyses performed on one set of groundwater samples obtained at one point in time. To confirm this assessment of the site conditions, we recommend that the observation wells continue to be flushed and that two additional sets of groundwater samples be collected and analyzed on approximately monthly intervals.

3. We recommend that four additional observation wells be installed along the northern property line between OWC-14 and B-219. Two of the wells may be installed in the loess to evaluate potential migration of arsenic and organic pesticides in the groundwater from the observed areas of contamination in the processing areas. The present location of observation wells does not allow an assessment of groundwater quality northwest of the area of known contamination. One well may be installed into the shallow limestone along the property line north of OWC-12 to evaluate the movement of pesticides in the limestone bedrock. One additional well may be installed deeper into the limestone to evaluate vertical movement of pesticides in the bedrock.

4. Additional review is recommended to determine the hazardous nature of the materials in the soil pile and pond sediments. The EP toxicity tests gave negative results; however, wasted soils which contain specific listed hazardous wastes are considered hazardous wastes and are subject to the hazardous waste regulations.

5. Care should be exercised in disposal of materials containing arsenic or pesticides which are not considered to be hazardous wastes. Additional chemical analyses are recommended to characterize the contaminants and to help evaluate the disposal procedures appropriate for these wastes.

LIMITATIONS

The boring logs depict subsurface conditions for the indicated locations and dates. With the passage of time, changes in the subsurface conditions may occur especially with respect to groundwater. Observation wells were located around the site to obtain a general characterization of the groundwater quality. Additional wells, permeability testing, and sampling and chemical testing are required to better define average site conditions and conditions at specific locations on the site. We request the opportunity to re-evaluate the field conditions and our interpretations relative to the design or implementation of any remedial measures if additional site information becomes available or if a significant time interval has elapsed from the date of this study.

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GLOSSARY

Part per million, ppm - a measure of proportion by weight, equivalent to a unit weight of solute per million (10^6) unit weights of solution.

Note - A part per million is generally considered equivalent to a milligram per liter, but this is not precise. A part per million is equivalent to a milligram of solute per kilogram of solution.

Part per billion, ppb - a measure of proportion by weight, equivalent to a unit weight of solute per billion (10^9) unit weights of solution.

Milligram per liter, mg/l - a weight-volume measurement which expresses the concentration of a solute in milligrams (10^{-3} grams) in a liter of solution.

Microgram per liter, ug/l - a weight-volume measurement which expresses the concentration of a solute in micrograms (10^{-6} grams) in a liter of solution.

Micron, um - a micron is a unit of length; 1 micron equals 10^{-6} meters (0.000001 meters). When used to describe a filter membrane, such as 0.45 micron pore-size membrane, the length refers to the nominal pore diameter.

TABLE 1

REPORTED DETAILS OF EXISTING WATER SUPPLY WELLS
SECTIONS 23 AND 26, T. 46 N., R.5E.

Well No.*	Missouri Survey No.	Owner	Section	Date Drilled	Surface Elevation	Total Depth(ft)	Reported Static Water Level In Feet Below Ground Surface	Productivity gallons/minute
1	8090	Maryland Heights School	23	1943	595	250	86	109 (85-foot drawdown)
2	8478	J. Pierlow	26	1943	548	325	31	1.5
3	10593	J. L. Tennant	26	1948	538	285	60	5
4	10598	L. Hageman & F. Schiell	26	1948	555	285	60	4.5
5	25256	E. Morrison	26	1967	526	305	20	8+
6	25364	M. Montgomery	26	1967	506	140	--	80+

* Numbers indicate well locations shown on the site location plan, Figure 1.

Data obtained from the files of the Missouri Geological Survey.

TABLE 2

OBSERVATION WELL INSTALLATION DETAILS

Well Designation	Elevation of Protective Casing (feet)	Elevation of Ground Surface*(feet)	Casing Diameter (inches)	Well Depth (feet)	Depth Over Which Well is Screened or Sand Packed**	Screen Slot Width (inches)
OWC-1	543.7	541	4	23	10.5 - 23.0	0.02
OWC-2	542.3	541	1.5	69.5	56.5 - 69.5	0.03
OWC-3	532.0	529	4	35	13.0 - 35.0	0.02
OWC-4	521.4	519	4	29.5	8.5 - 29.5	0.02
OWC-5	518.1	515	4	25	12.0 - 26.5	0.02
OWC-6	525.6	523	4	25	7.0 - 26.5	0.02
OWC-7	525.3	523	4	17	4.5 - 17.0	0.02
OWC-8	525.7	523	4	27.5	16.5 - 27.5	0.02
OWC-9	534.8	532	4	32	9.5 - 32.0	0.02
OWC-10	530.1	528	4	28	10.0 - 28.0	0.02
OWC-11	526.2	524	4	28	16.0 - 28.0	0.02
OWC-12	526.5	524	1.5	40.3	28.25 - 40.25	0.03
OWC-13	518.8	516	4	20	8.0 - 21.5	0.02
OWC-14	515.0	513	4	22	9.0 - 23.5	0.02
OWC-15	516.5	514	4	20	8.0 - 21.5	0.02

* Rounded to nearest foot

** The lower portion of the well is screened. The sand pack around the screen generally extends 2 to 3 feet above the top of the screen. Refer to Appendix B for individual well profiles.

Elevations based on USC & GS datum.

TABLE 3

DEVELOPING, FLUSHING AND SAMPLING
OF OBSERVATION WELLS

Well	Number of Times Bailed Prior to Initial Sampling	Date Flushed	Water Elevation Prior to Flushing	Date Sampled	Water Elevation Prior to Sampling
OWC-1	3	2-24-81	537.8	2-26-81	537.5
OWC-2	3	2-26-81	482.8	2-27-81*	483.5
OWC-3	4	2-24-81	522.5	2-26-81	522.3
OWC-4	4	2-23-81	513.1	2-24-81	513.0
OWC-5	6	2-24-81	510.3	2-25-81	510.6
OWC-6	7	2-23-81	517.4	2-24-81	517.3
OWC-7	3	2-23-81	517.8	2-24-81	517.5
OWC-8	2	2-23-81	518.4	2-24-81	518.3
OWC-9	4	2-24-81	529.6	2-26-81	529.1
OWC-10	3	2-23-81	523.4	2-24-81	523.0
OWC-11	3	2-23-81	517.1	2-24-81	517.0
OWC-12	3	2-25-81	516.6	2-26-81	516.6
OWC-13	6	2-24-81	513.1	2-25-81	513.4
OWC-14	6	2-24-81	509.2	2-25-81	507.5
OWC-15	6	2-24-81	505.0	2-25-81	505.0

* OWC-2 was not sampled.

USC & GS elevation datum.

TABLE 4

GROUNDWATER PARAMETERS MEASURED DURING SAMPLING

Well	pH *	Specific Conductivity** μmhos/cm	Temperature** °C
OWC-1	6.3	960	12.8
OWC-3	6.4	1250	14.0
OWC-4	6.3	1840	12.1
OWC-5	6.5	1170	13.0
OWC-6	6.2	860	14.5
OWC-7	6.5	1480	14.0
OWC-8	6.7	1090	14.5
OWC-9	6.7	520	11.5
OWC-10	6.3	840	12.4
OWC-11	7.0	1200	12.0
OWC-12	7.2	700	16.3
OWC-13	6.6	1170	13.0
OWC-14	6.8	860	13.2
OWC-15	6.3	295	16.5

* Cole-Parmer Digi-sense LCD pH meter Model No. 5994-10.

** Yellow Springs Instrument salinity, conductivity and temperature meter Model No. 33.

TABLE 5

OBSERVED GROUNDWATER LEVELS
+ USGS Elevation (feet)

	February 1981														March 1981		
Well No.	9	12	13	16	17	18	19	20	21	23	24	25	26	27	11	17	19
OWC-1	-	-	-	-	-	-	533.6	534.4*	-	537.8	537.8	-	537.5	537.2	537.6	537.6	537.4
OWC-2	-	-	-	-	-	-	-	-	-	539.3	-	486.2*	482.8*	483.5*	488.2	490.6	491.5
OWC-3	-	-	-	-	523.0	522.3*	-	522.1	-	522.3	522.5	-	522.3	522.5	522.8	522.7	522.5
OWC-4	-	-	-	-	513.2	513.1*	-	512.6	-	513.1	513.0*	-	-	512.5	512.0	511.3	510.8
OWC-5	509.8	509.5	509.1*	510.2	-	-	510.6	-	-	510.6	510.3	510.6*	-	510.6	-	511.1	510.8
OWC-6	515.8	516.2	516.2*	517.5	-	517.4	-	-	-	517.4	517.3*	-	-	517.1	517.1	516.9	516.8
OWC-7	-	-	-	-	-	-	-	517.7	517.5*	517.8	517.5*	-	-	517.7	517.8	517.8	517.7
OWC-8	-	-	-	-	-	-	-	-	518.9	518.4	518.3*	-	-	518.2	518.4	518.4	518.2
OWC-9	-	529.1	529.1*	-	529.6	529.8	--	-	-	529.8	529.6*	-	529.1	529.3	529.8	529.7	529.7
OWC-10	-	-	-	523.3	-	523.5	-	-	-	523.4	523.0*	-	-	522.8	523.1	523.4	523.2
OWC-11	-	-	-	-	-	-	-	516.8	516.8*	517.1	517.0*	-	-	516.7	-	516.7	516.5
OWC-12	-	-	-	-	-	-	-	-	-	516.7	516.7*	516.6	516.6*	516.6	516.9	516.8	516.7
OWC-13	512.8	512.4	512.5*	513.0	-	-	513.5	-	-	513.3	513.1	513.4*	-	513.3	513.5	513.6	513.3
OWC-14	505.2	-	505.9*	508.9	-	-	509.2	-	-	509.4	509.2	507.5*	-	508.9	509.4	509.3	509.2
OWC-15	504.8	504.2	504.4*	504.6	-	-	504.8	-	-	505.0	505.0	505.0*	-	505.0	-	505.7	505.6

* The well was bailed within twenty-four hours prior to measuring this water level and may not have fully recovered to static level.

Water levels measured by WCC personnel using Soil Test electronic water level indicator.

TABLE 5

OBSERVED GROUNDWATER LEVELS
USGS Elevation (feet)

Well No.	February 1981														March 1981		
	9	12	13	16	17	18	19	20	21	23	24	25	26	27	11	17	19
OWC-1	-	-	-	-	-	-	533.6	534.4*	-	537.8	537.8	-	537.5	537.2	537.6	537.6	537.4
OWC-2	-	-	-	-	-	-	-	-	-	539.3	-	486.2*	482.8*	483.5*	488.2	490.6	491.5
OWC-3	-	-	-	-	523.0	522.3*	-	522.1	-	522.3	522.5	-	522.3	522.5	522.8	522.7	522.5
OWC-4	-	-	-	-	513.2	513.1*	-	512.6	-	513.1	513.0*	-	-	512.5	512.0	511.3	510.8
OWC-5	509.8	509.5	509.1*	510.2	-	-	510.6	-	-	510.6	510.3	510.6*	-	510.6	-	511.1	510.8
OWC-6	515.8	516.2	516.2*	517.5	-	517.4	-	-	-	517.4	517.3*	-	-	517.1	517.1	516.9	516.8
OWC-7	-	-	-	-	-	-	-	517.7	517.5*	517.8	517.5*	-	-	517.7	517.8	517.8	517.7
OWC-8	-	-	-	-	-	-	-	-	518.9	518.4	518.3*	-	-	518.2	518.4	518.4	518.2
OWC-9	-	529.1	529.1*	-	529.6	529.8	--	-	-	529.8	529.6*	-	529.1	529.3	529.8	529.7	529.7
OWC-10	-	-	-	523.3	-	523.5	-	-	-	523.4	523.0*	-	-	522.8	523.1	523.4	523.2
OWC-11	-	-	-	-	-	-	-	516.8	516.8*	517.1	517.0*	-	-	516.7	-	516.7	516.5
OWC-12	-	-	-	-	-	-	-	-	-	516.7	516.7*	516.6	516.6*	516.6	516.9	516.8	516.7
OWC-13	512.8	512.4	512.5*	513.0	-	-	513.5	-	-	513.3	513.1	513.4*	-	513.3	513.5	513.6	513.3
OWC-14	505.2	-	505.9*	508.9	-	-	509.2	-	-	509.4	509.2	507.5*	-	508.9	509.4	509.3	509.2
OWC-15	504.8	504.2	504.4*	504.6	-	-	504.8	-	-	505.0	505.0	505.0*	-	505.0	-	505.7	505.6

* The well was bailed within twenty-four hours prior to measuring this water level and may not have fully recovered to static level.

Water levels measured by WCC personnel using Soil Test electronic water level indicator.

TABLE 6

SLUG TEST RESULTS *

Well	Depth of Screened Interval, ft	Coefficient of Permeability ft/day	Coefficient of Permeability cm/sec
OWC-6	8 - 25	1	5×10^{-4}
OWC-7	7 - 17	0.3	1×10^{-4}
OWC-8	18.5 - 27.5	0.1	3×10^{-5}
OWC-9	12 - 32	0.2	7×10^{-5}
OWC-15	10 - 20	3	1×10^{-3}
		4.6	

* Methodology presented by Bower and Rice, 1976

TABLE 7

ARSENIC IN SOIL

Vertical distribution of arsenic in soil samples (parts per million)*

B-219 Sample Depth (ft)	Arsenic Concentration ug/g
2 - 3.5	480
4 - 5.5	160
6 - 7.5	31
10 - 11.5	3.6
15 - 16.5	3.3
20 - 21.5	5.5

B-203 Sample Depth (ft)	Arsenic Concentration ug/g
5 - 6.5	4.9
10 - 11.5	4.1

OWC-10 Sample Depth (ft)	Arsenic Concentration ug/g
4 - 5.5	5.5

OWC-11 Sample Depth (ft)	Arsenic Concentration ug/g
1 - 2.5	570

* Samples analyzed for total arsenic in accordance with procedures published in the Federal Register, Vol. 44, No. 233, December 23, 1979.

TABLE 8

Parameters Proposed for Analysis of Samples

Organochlorine Pesticides

DDE	Toxaphene
DDT	Lindane
Endrin	Kelthane (not analyzed)
Dieldrin	DDD (TDE)
Aldrin	Captan
Mirex	Methoxychlor
Heptachlor	PCB's
Chlordane	Difolatan
Chlorobenzilate	

Organophosphorus Pesticides

Thosdrin (Mevinphos)	Parathion
Diazinon	Trithion (not analyzed)
Guthion	Malathion

Phenoxyacid Herbicides

- 2,4-D
- 2,4,5-T

Miscellaneous Pesticides (not analyzed)

- Rotenone
- Amitrole
- Sevin

Heavy Metals

- Arsenic
- Copper
- Zinc
- Cadmium

Total Organic Carbon

Standard Water Chemistry Analyses

Note: pH, salinity, conductivity and temperature are determined in the field when the water samples are obtained.

TABLE 9

COMPARISON OF SELECTED PESTICIDE CONSTITUENTS
IN SOIL AND GROUNDWATER FROM OWC-10

	Analyses from OWC-10	
Constituent	Concentration In Soil* (4 to 5.5 ft) ug/g(ppm)	Concentration In Groundwater mg/l
Aldrin	11.9	.0121
Chlordane	ND(4.0)	ND(.001)
4,4-DDD	22.1	ND(.0002)
4,4-DDE	7.37	ND(.0002)
4,4-DDT	44.2	ND(.0003)
Dieldrin	1.99	ND(.0002)
Endrin	1.89	ND(.0004)
Heptachlor	8.04	.00858
Toxaphene	ND(10.0)	ND(.01)
PCB	ND(10.0)	ND(.01)
Lindane	2.72	.0298
Methoxychlor	ND(4.0)	ND(.0008)
Mirex	ND(4.0)	ND(.0005)
Captan	ND(4.0)	ND(.0002)
Difolatan	ND(4.0)	ND(.02)
Chlorobenzilate	ND(4.0)	ND(.0003)
Arsenic	5.5	.006

*The soil sample was obtained approximately 1 foot above the static groundwater level.

Soil samples were analyzed on a total extraction basis. The organic analyses of soil and water samples were performed in accordance with procedures published in the Federal Register, Vol. 38, No. 75, Pt. II. Groundwater samples were filtered through a glass fiber filter of 1 micron pore size prior to analysis. Analysis for total arsenic was performed in accordance with procedures published in the Federal Register, Vol. 44, No. 233, December 23, 1979.

TABLE 10

COMPARISON OF SELECTED PESTICIDE CONSTITUENTS
IN SOIL AND GROUNDWATER FROM OWC-11

	Analyses from OWC-11	
Constituent	Concentration In Soil* (1.0 to 2.5 ft) ug/g(ppm)	Concentration in Groundwater mg/l
Aldrin	100	ND(.00012)
Chlordane	ND(4.0)	ND(.001)
4,4-DDD	351	.00146
4,4-DDE	126	ND(.0002)
4,4-DDT	703	.00146
Dieldrin	113	.0173
Endrin	95.2	.00055
Heptachlor	17.8	ND(.0001)
Toxaphene	ND(10.0)	ND(.01)
PCB	ND(10.0)	ND(.01)
Lindane	2.78	.106
Methoxychlor	ND(4.0)	ND(.0008)
Mirex	ND(4.0)	ND(.0005)
Captan	ND(4.0)	ND(.0002)
Difolatan	ND(4.0)	ND(.02)
Chlorobenzilate	ND(4.0)	ND(.0003)
Arsenic	570	.110

* The soil sample was obtained approximately 3 feet above the static groundwater level.

Soil samples were analyzed on a total extraction basis. The organic analyses of soil and water samples were performed in accordance with procedures published in the Federal Register, Vol. 38, No. 75, Pt. II. Groundwater samples were filtered through a glass fiber filter of 1 micron pore size prior to analysis. Analysis for total arsenic was performed in accordance with procedures published in the Federal Register, Vol. 44, No. 233, December 23, 1979.

TABLE 11

Extraction Procedure Toxicity Analyses

Analyses were performed according to "Methods for Analysis of Water and Wastes", EPA-600/4-79-020, using a Perkin-Elmer 503 Atomic Absorption Spectrophotometer equipped with a flame and graphite furnace. Analyses were performed by Bruce Fast and Robert Rickard.

Organic compounds were analyzed, according to "Methods for Benzidine, Chlorinated Organic Compounds, Pentachlorophenol and Pesticides in Water and Wastewater", U.S.E.P.A., September 1978, on a Hewlett-Packard 5710 gas chromatograph equipped with a Ni63 electron capture detection on a 1.5% SP-2250/1.95% SP-2401 Supelcoport 100/120 column at 185°C with a carrier gas flow of 60 ml/min. Analyses were performed by Clifford Baker.

			Analyses Results		
			Soil beneath Pond	Sediment from Pond	Soil from Waste Pile
Analysis	EPA Hazardous Waste Number	Toxicity Limit (mg/l)	S81-5 B212 7 ft. 3-3,4 8103-0213E	S81-5 B212 3 ft. 1-3,4 8103-0213E	S81-5 Soil Pile 8103-0184E
Arsenic	D004	5.0	ND(0.05)	2.8	0.033
Barium	D005	100	ND(0.2)	ND(1.0)	ND(0.2)
Cadmium	D006	1.0	ND(0.05)	ND(.01)	ND(0.05)
Chromium	D007	5.0	ND(0.05)	ND(.05)	0.20
Lead	D008	5.0	ND(0.2)	ND(.10)	ND(0.2)
Mercury	D009	0.20	ND(0.001)	ND(.0001)	ND(0.001)
Selenium	D010	1.0	ND(0.01)	ND(.01)	ND(0.01)
Silver	D011	5.0	ND(0.05)	ND(.05)	ND(0.05)
Endrin	D012	0.02	ND(0.005)	ND(.005)	ND(0.005)
Lindane	D013	0.4	ND(0.0012)	ND(.001)	0.021
Methoxychlor	D014	10.0	ND(0.05)	ND(.05)	ND(0.05)
Toxaphene	D015	0.5	ND(0.05)	ND(.05)	ND(0.05)
2,4-D	D016	10.0	ND(0.01)	ND(.01)	ND(0.01)
2,4,5-TP	D017	1.0	ND(0.005)	.019	ND(0.005)

ND denotes none detected. The detection limit of the method is shown in parentheses.

WILSON LABORATORIES

Robert L. Meyer
Chief Chemist

EP TOXICITY TEST RESULTS FOR SOIL/ROCK WASTE PILE
AND NATURAL SOIL APPROXIMATELY 4 FEET BELOW THE BOTTOM OF THE
STORM WATER RETENTION POND

S81-5

File No. 81-9521
Lab No. 8103-0213E & 8103-0184E
Date: 13 March 1981

TABLE 12

GROUNDWATER QUALITY ANALYSES - ORTHO-CHEVRON, MARYLAND HEIGHTS, MISSOURI

Concentrations, ug/l (ppb)

Organic Constituents	OWC-1	OWC-3	OWC-4	OWC-5	OWC-6	OWC-7	OWC-8	OWC-9	OWC-10	OWC-11	OWC-12	OWC-13	OWC-14	OWC-15	Detection Limit	EPA Drinking Water Standards*	Missouri Groundwater Recharge Standards*
2,4-D	1.8	ND	47	ND	1.1	2.6	87.8	ND	30.9	2300	ND	1.3	ND	ND	1.0	100	--
2,4,5-T	ND	.1	1.9	ND	ND	.2	9.7	ND	15.7	18.8	1.2	.8	ND	ND	.1	10	--
4,4-DDD	ND	ND	ND	ND	2.53	ND	ND	1.08	ND	1.46	ND	.3	.5	ND	.2	--	--
4,4-DDE	ND	ND	ND	ND	ND	ND	ND	.22	ND	ND	ND	.35	ND	ND	.2	--	--
4,4-DDT	ND	ND	ND	ND	.96	ND	ND	.53	ND	1.46	4.8	ND	ND	ND	.3	--	--
Aldrin	.12	ND	ND	ND	6.94	63.3	4.59	.26	12.1	ND	17.7	16.3	.88	ND	.12	--	--
Diazinon	ND	1.7	1.6	ND	27.3	427	37.8	ND	377	11.1	4.3	ND	ND	ND	.5	--	--
Dieldrin	ND	ND	ND	ND	3.89	ND	1.45	.55	ND	17.3	7.8	1.06	.69	.21	.2	--	--
Endrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	.55	4.3	ND	ND	ND	.4	.2	--
Ethyl-Parathion	ND	ND	ND	ND	.8	12.9	2.5	ND	ND	ND	53.2	ND	ND	ND	.5	--	--
Heptachlor	ND	ND	1.76	ND	4.52	ND	ND	ND	8.58	ND	ND	ND	ND	ND	.1	--	--
Lindane	.26	1.07	1.25	.29	43.2	1880	184	.82	29.8	106	417	2300	.93	.23	.1	4.0	--
Malathion	ND	ND	ND	ND	ND	100	ND	ND	6.6	5.7	223	ND	ND	ND	2.0	--	--
Methyl-Parathion	ND	ND	ND	3.8	2.2	6.1	1.6	ND	26.7	2.5	10.9	ND	ND	ND	2.0	--	--
Mirex	ND	ND	3.07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	.5	--	--
PCB	ND	ND	ND	ND	1600	ND	ND	ND	ND	ND	ND	ND	ND	ND	10.0	--	--
Phosdrin	ND	ND	ND	ND	2.3	7.9	ND	ND	ND	ND	ND	ND	ND	ND	2.0	--	--

The following organic pesticide compounds were analyzed for and were not detected in any of the groundwater samples:

Constituent	Detection Limit, ug/l (ppb)
Captan	.20
Chlordane	1.0
Chlorobenzilate	.30
Difolatan	20.0
Guthion	100.0
Methoxychlor	.8
Toxaphene	10.0

The samples were not analyzed for: Kelthane, Trithion, Rotenone, Amitrole, and Sevin.

Groundwater samples for organic analyses were filtered through 1 micron pore size glass fiber filters prior to analysis. Samples for organic analyses were analyzed in accordance with procedures published in the Federal Register, Volume 38, No. 75, Part II.

*The EPA Drinking Water Standards and Missouri Groundwater Recharge Standards are shown for comparison purposes only.

S81-5

TABLE 12

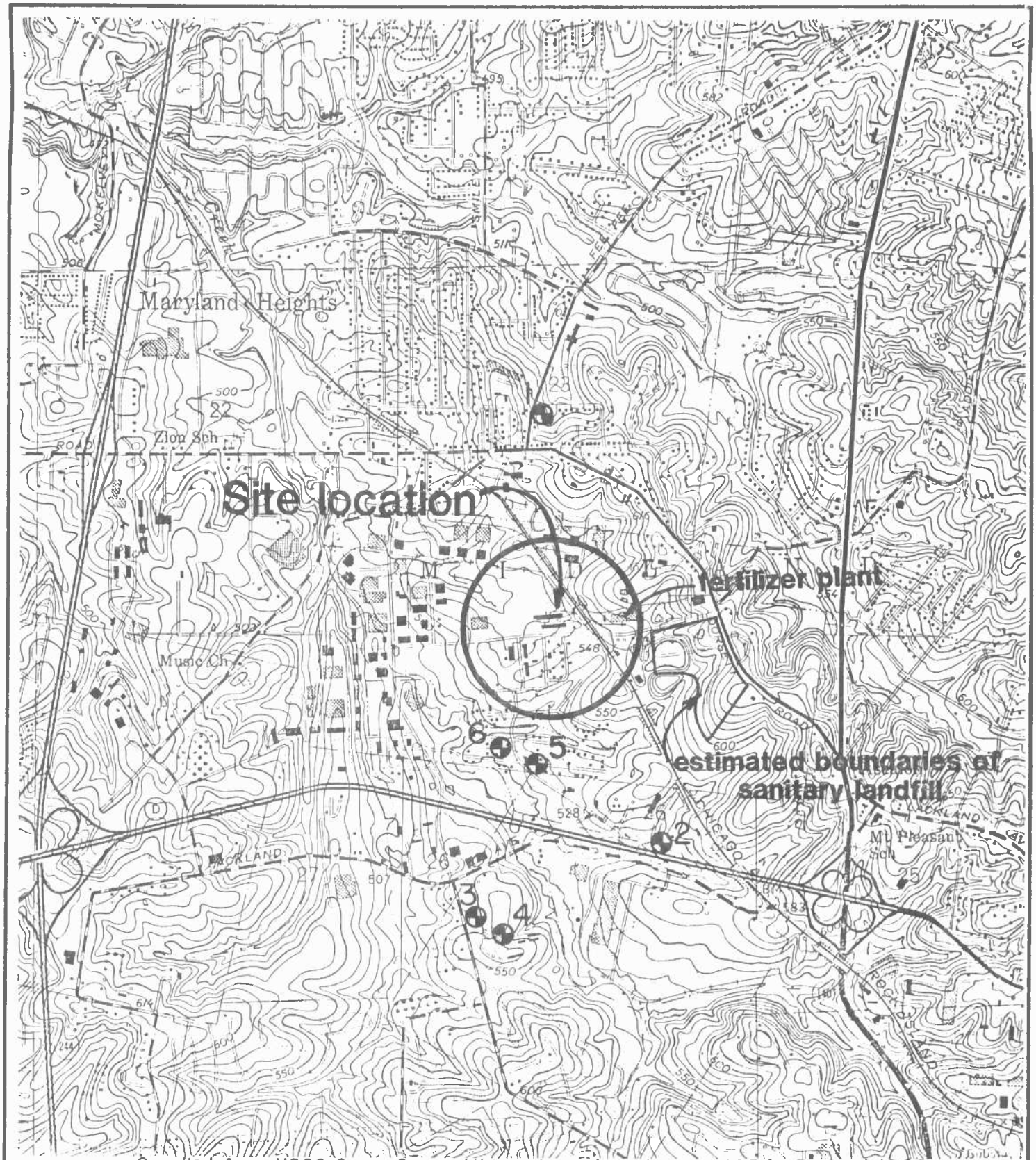
GROUNDWATER QUALITY ANALYSES - ORTHO-CHEVRON, MARYLAND HEIGHTS, MISSOURI

Concentrations, mg/l (ppm)

Inorganic Constituents	OWC-1	OWC-3	OWC-4	OWC-5	OWC-6	OWC-7	OWC-8	OWC-9	OWC-10	OWC-11	OWC-12	OWC-13	OWC-14	OWC-15	Detection Limit	EPA Drinking Water Standards*	Missouri Groundwater Recharge Standards*
Arsenic	.01	.024	ND	.003	.056	.13	.005	.005	.006	.11	ND	ND	.008	ND	.001	.05	.05
Cadmium	.0005	.0006	.0021	.001	.0021	.012	.001	ND	.010	.001	.001	.0006	.0018	ND	.0005	.01	.01
Copper	.0027	.0069	.0023	.012	.0018	.096	.0028	.0015	.063	.0034	.0055	.0032	.020	.002	-	1.0	.02
Zinc	.05	.04	.048	.07	.039	.36	.059	.04	.24	.061	.03	.05	.08	.03	-	5.0	.1
pH	6.3	6.4	6.3	6.5	6.2	6.5	6.7	6.7	6.3	7.0	7.2	6.6	6.8	6.3	-	6.5 - 8.5	6.5 - 9.0
Total Dissolved Solids	788	855	1190	860	638	1255	907	550	777	876	634	1000	756	273	-	500	-
Chloride	142	284	540	46	116	296	120	7	112	264	20	232	74	29	-	250	-
Flouride	.22	.14	.11	.14	.19	.24	.21	.52	.20	.17	.34	.14	.17	.14	-	1.4 - 2.4	2.0
Nitrate (as NO_3)	11.5	8.0	12.4	0.0	4.0	0.0	.9	6.2	0.0	1.8	1.3	0.0	4.43	8.4	-	45	45
Sulfate	140	115	75	95	145	220	95	35	115	125	125	200	100	60	-	250	-

Groundwater samples to be analyzed for heavy metals were filtered through 0.45 micron pore size filter membranes and acid preserved at the time of collection. The groundwater samples analyzed for inorganics were analyzed in accordance with procedures published in the Federal Register, Volume 44, No. 233, December 23, 1979.

*The EPA Drinking Water Standards and Missouri Groundwater Recharge Standards are shown for comparison purposes only.



Compiled from USGS Creve Coeur, Missouri quadrangle map, 1954, Revised 1968.

1 — Approximate locations of public and private water supply wells in the immediate vicinity of the plant. Refer to Table I for well details.

0 1000 2000
SCALE, ft

HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS
MARYLAND HEIGHTS, MISSOURI
ORTHO-CHEVRON CHEMICAL COMPANY

PROJECT NO. S 81-5

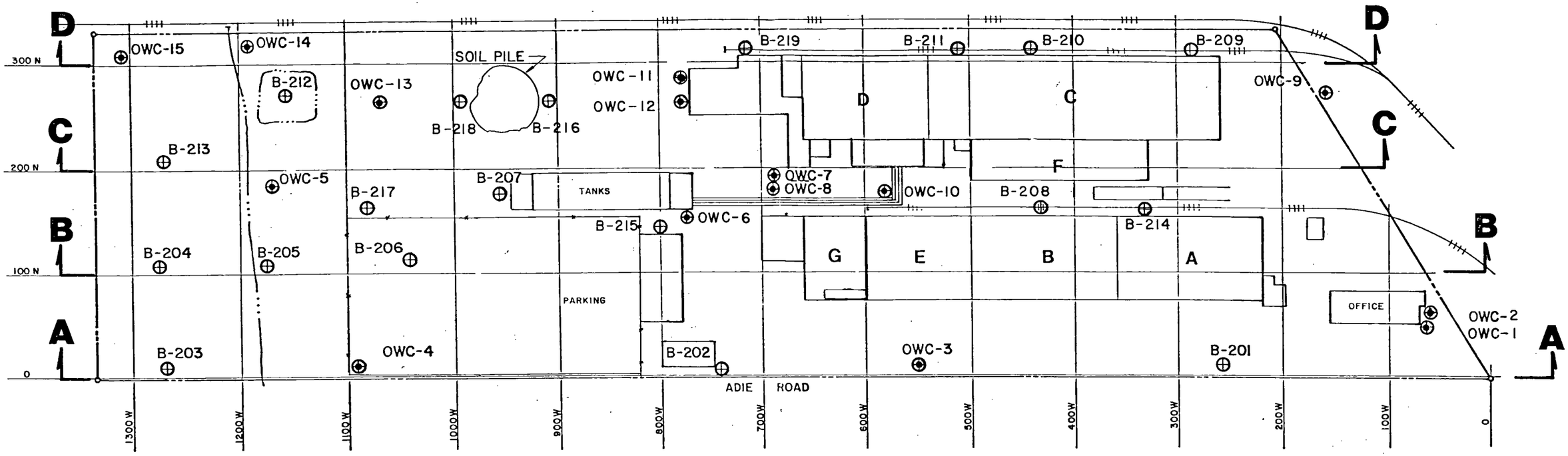
WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS
CENTRAL REGION

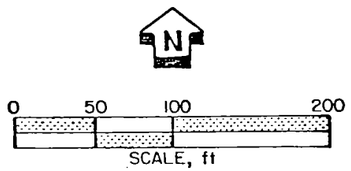
DRN. BY: KM 3-29-81
CHKD. BY: JK

SITE LOCATION MAP

FIG. NO. 1

Reproduced from the site plan provided by the Ortho-Chevron Chemical Company.





A — Geologic cross-sections; refer to figures 3 through 6.

B-201 — Exploratory boring location and number

OWC-1 — Groundwater well location and designation

HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS
MARYLAND HEIGHTS, MISSOURI
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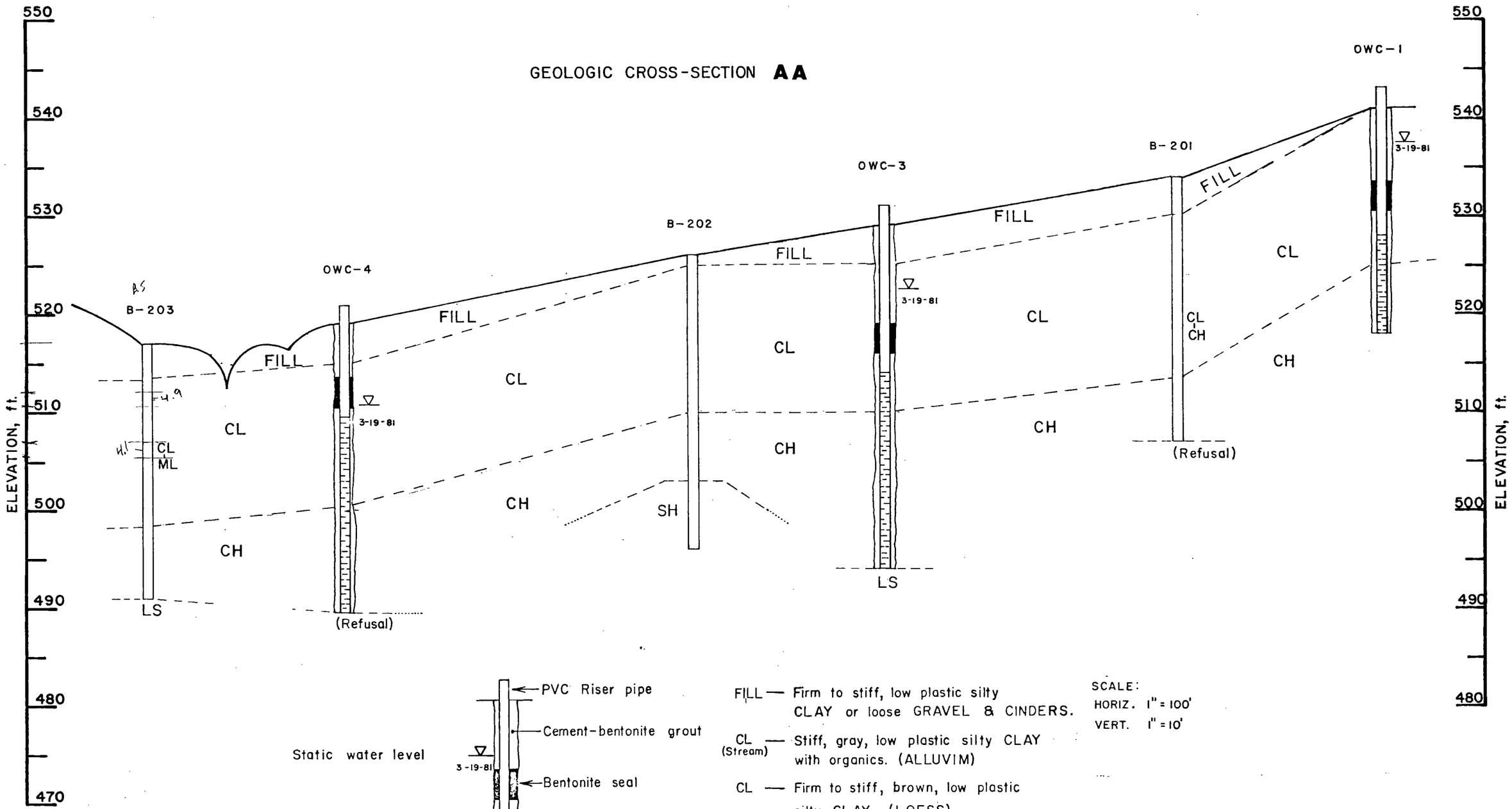
DRN. BY: KM 3-10-81
CHKD. BY: PJK

SITE PLAN

FIG. NO. 2

GEOLOGIC CROSS-SECTION **AA**



Static water level

FILL — Firm to stiff, low plastic silty CLAY or loose GRAVEL & CINDERS.

CL (Stream) — Stiff, gray, low plastic silty CLAY with organics. (ALLUVIM)

CL — Firm to stiff, brown, low plastic silty CLAY. (LOESS)

CH — Stiff to hard, brown, highly plastic CLAY, (RESIDUAL)

SH — SHALE, Hard, gray, unweathered.

LS — LIMESTONE, light gray, weathered to unweathered.

SCALE:
HORIZ. 1" = 100'
VERT. 1" = 10'

NOTE:
THESE LOGS HAVE BEEN GENERALIZED TO ILLUSTRATE GENERAL SUBSURFACE CONDITIONS. REFER TO INDIVIDUAL BORING LOGS FOR DETAILS — APPENDIX A.

HYDROGEOLOGIC AND GROUNDWATER STUDY
ORTHO-CHEVRON CHEMICAL COMPANY PLANT
MARYLAND HEIGHTS, MISSOURI

PROJECT NO. S-81-5

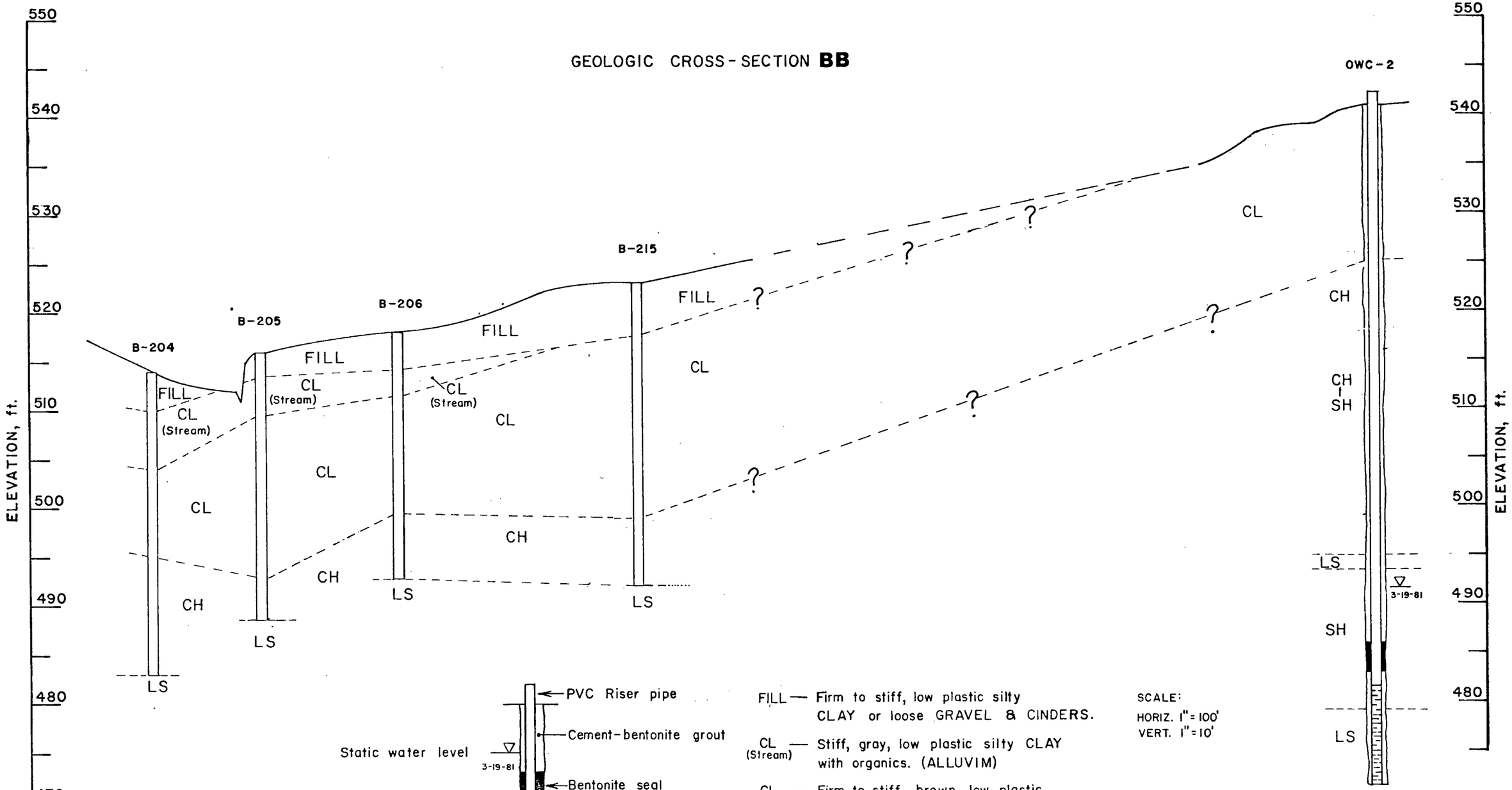
WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS
CENTRAL REGION

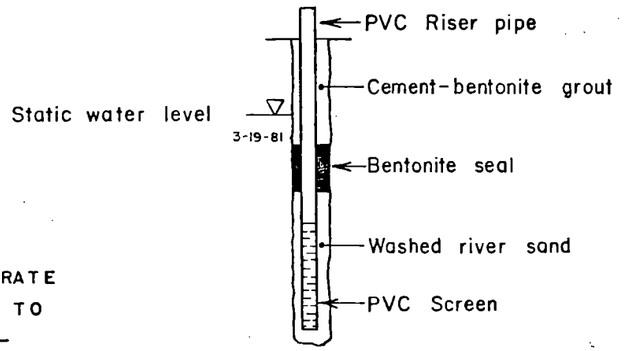
DRN. BY: PJK/JG 3-30-81
CHKD. BY: PJK

GENERALIZED BORING LOGS

FIG. NO. 3

GEOLOGIC CROSS-SECTION **BB**





FILL — Firm to stiff, low plastic silty CLAY or loose GRAVEL & CINDERS.

CL (Stream) — Stiff, gray, low plastic silty CLAY with organics. (ALLUVIM)

CL — Firm to stiff, brown, low plastic silty CLAY. (LOESS)

CH — Stiff to hard, brown, highly plastic CLAY, (RESIDUAL)

SH — SHALE, Hard, gray, unweathered.

LS — LIMESTONE, light gray, weathered to unweathered.

SCALE:
HORIZ. 1" = 100'
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NOTE:
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HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS
MARYLAND HEIGHTS, MISSOURI
ORTHO-CHEVRON CHEMICAL COMPANY

PROJECT NO. S 81-5

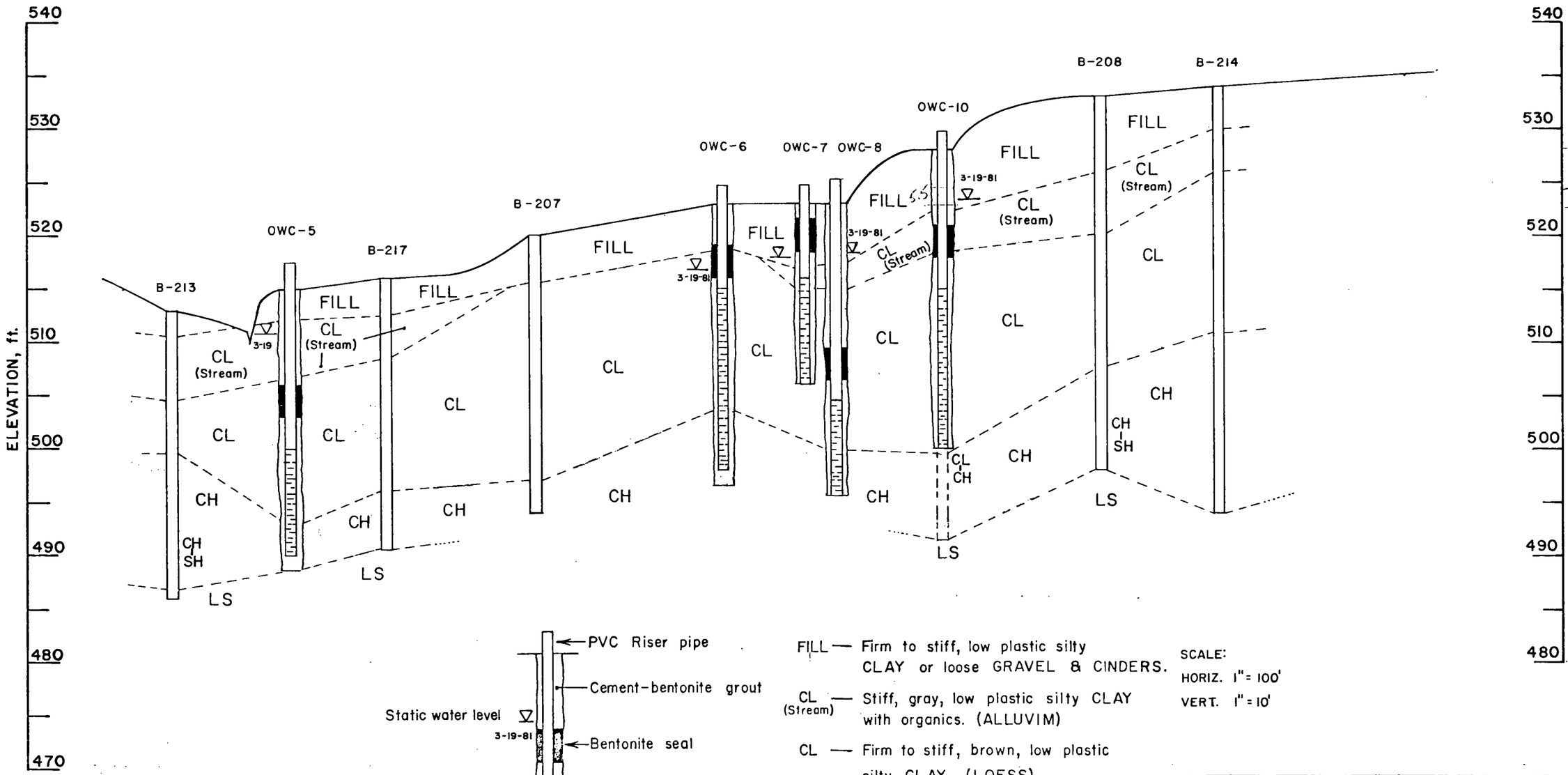
WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS
CENTRAL REGION

DRN. BY: J.G. 3-27-81
CHKD. BY: PJK

GENERALIZED BORING LOGS

FIG. NO. 4

GEOLOGIC CROSS-SECTION **CC**



FILL — Firm to stiff, low plastic silty CLAY or loose GRAVEL & CINDERS.

CL (Stream) — Stiff, gray, low plastic silty CLAY with organics. (ALLUVIM)

CL — Firm to stiff, brown, low plastic silty CLAY. (LOESS)

CH — Stiff to hard, brown, highly plastic CLAY, (RESIDUAL)

SH — SHALE, Hard, gray, unweathered.

LS — LIMESTONE, light gray, weathered to unweathered.

SCALE:
HORIZ. 1" = 100'
VERT. 1" = 10'

NOTE:
THESE LOGS HAVE BEEN GENERALIZED TO ILLUSTRATE GENERAL SUBSURFACE CONDITIONS. REFER TO INDIVIDUAL BORING LOGS FOR DETAILS — APPENDIX A.

HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS
MARYLAND HEIGHTS, MISSOURI
ORTHO-CHEVRON CHEMICAL COMPANY

PROJECT NO. S 81-5

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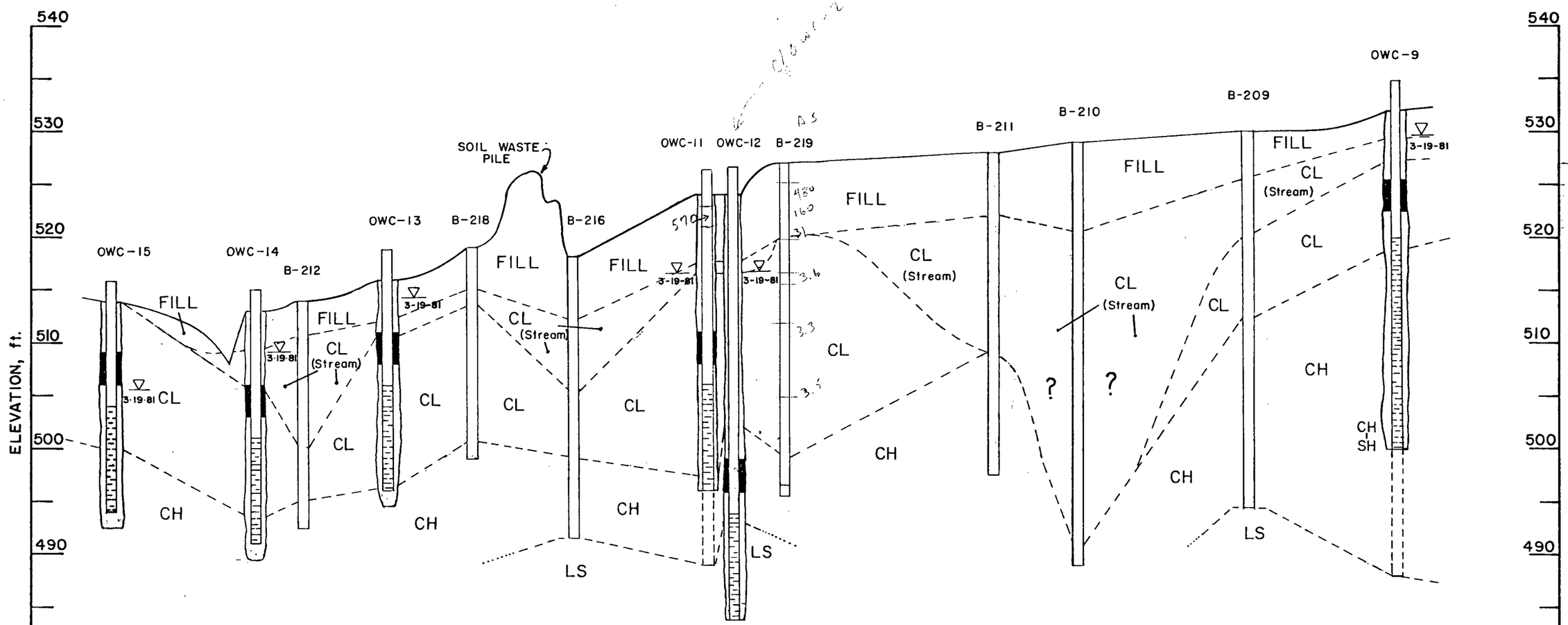
CENTRAL REGION

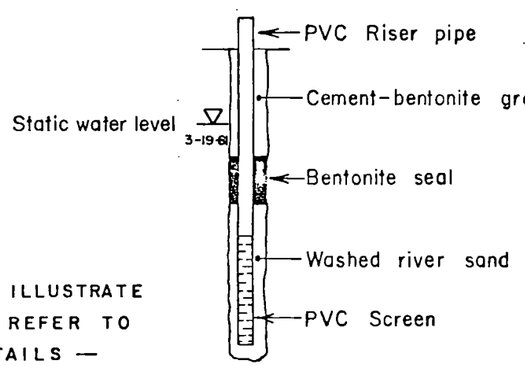
DRN. BY: V.G. 3-27-81
CHKD. BY: PJK

GENERALIZED BORING LOGS

FIG. NO. 5

GEOLOGIC CROSS-SECTION **DD**





FILL — Firm to stiff, low plastic silty CLAY or loose GRAVEL & CINDERS.

CL (Stream) — Stiff, gray, low plastic silty CLAY with organics. (ALLUVIM)

CL — Firm to stiff, brown, low plastic silty CLAY. (LOESS)

CH — Stiff to hard, brown, highly plastic CLAY, (RESIDUAL)

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LS — LIMESTONE, light gray, weathered to unweathered.

SCALE:
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NOTE:
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HYDROGEOLOGY STUDY & GROUNDWATER CHARACTERISTICS
MARYLAND HEIGHTS, MISSOURI
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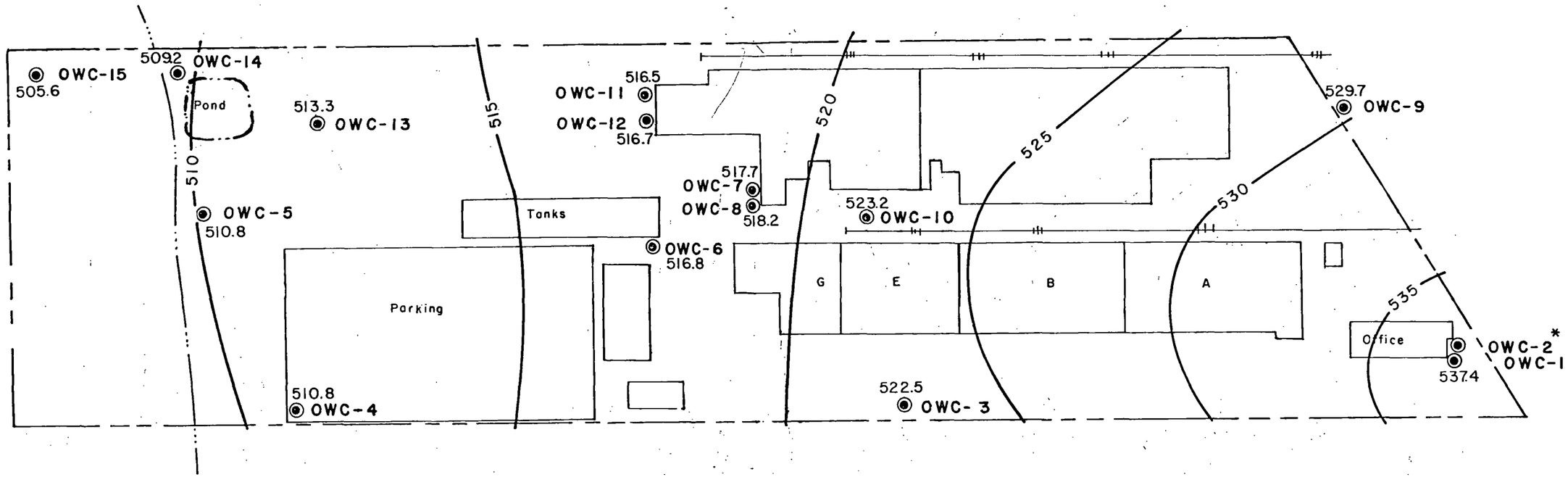
CENTRAL REGION

DRN. BY: J.G. 3-27-81
CHKD. BY: PJK

GENERALIZED BORING LOGS

FIG. NO. 6



GROUNDWATER CONTOUR MAP

OWC-1 537.4 — Groundwater observation well and observed groundwater elevation

530 — Groundwater contour, feet

Interpreted from water levels observed on 3-19-81

DEPTHS of NESTED WELLS

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

REFER TO TABLE 2 OR APPENDIX B FOR OBSERVATION WELL DETAILS

N

0 50 100 200

SCALE, ft

*OWC-2 was not included

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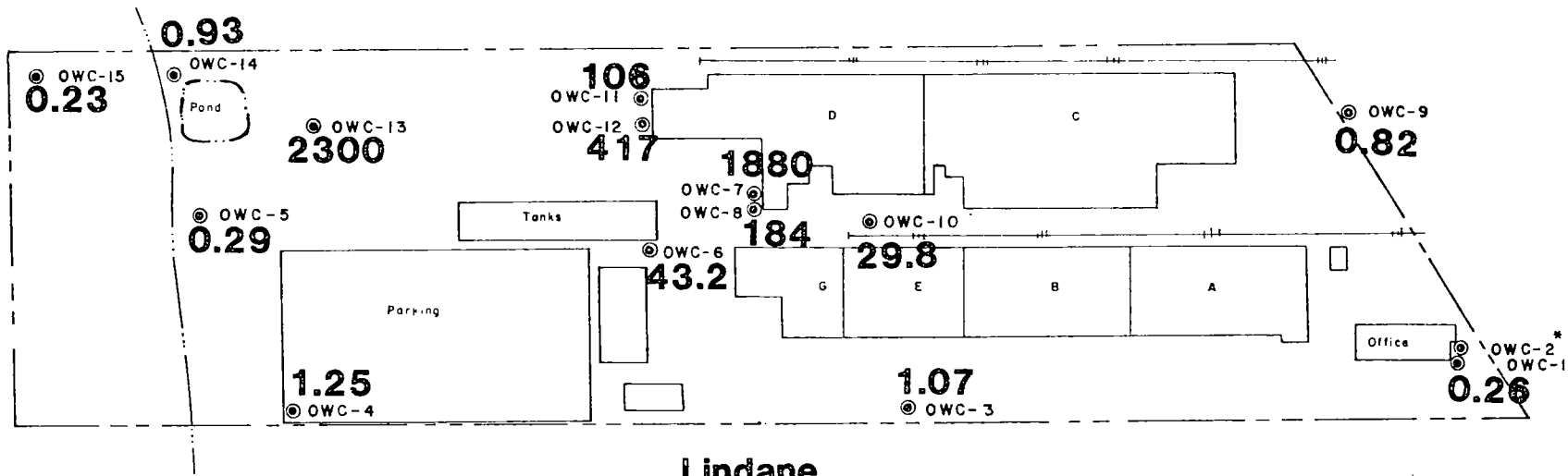
GROUNDWATER CONTOUR MAP

FIG. NO. 7



Lindane

µg/l

— WATER QUALITY ANALYSIS —

OWC-1 ◉ — Groundwater observation well

23 — Concentration, µg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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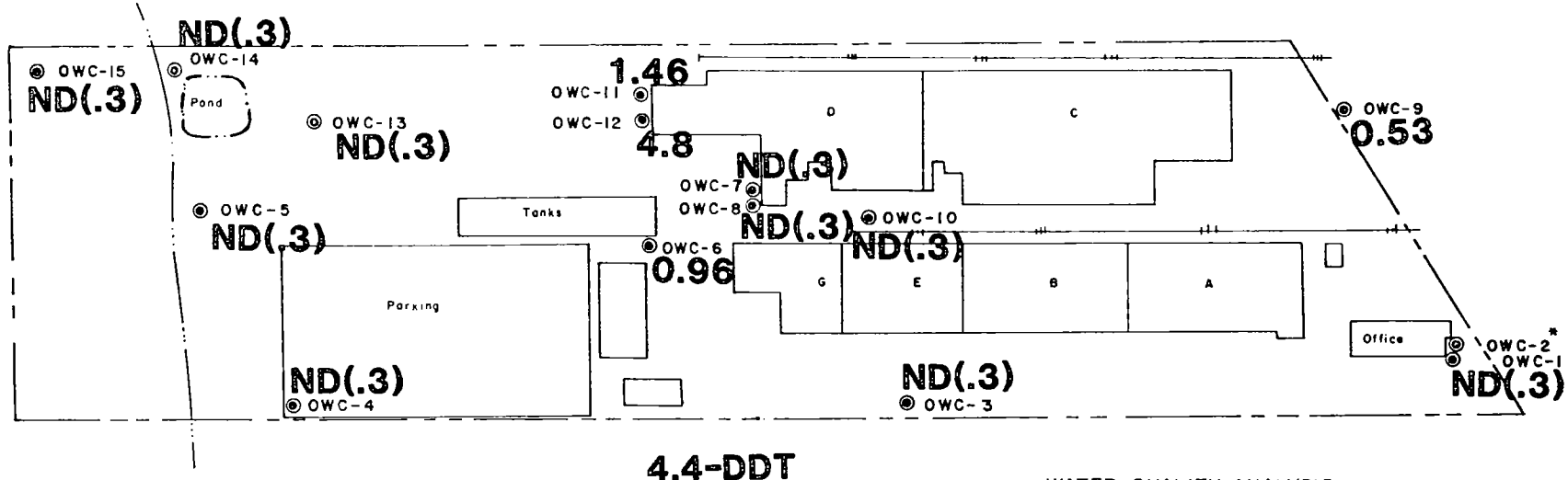
FIG. NO 8



4,4-DDT

µg/l

— WATER QUALITY ANALYSIS —

OWC-1 ◉ — Groundwater observation well

1.32 — Concentration, µg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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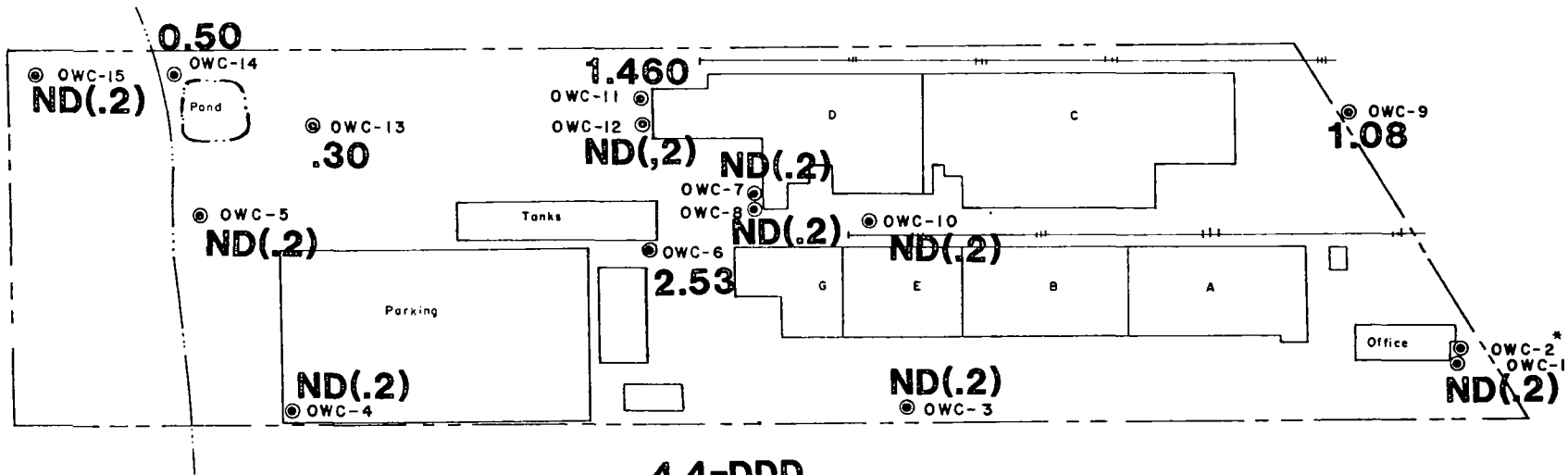
FIG. NO. 9



4,4-DDD

µg/l

— WATER QUALITY ANALYSIS —

OWC-1 ◉ — Groundwater observation well

2.53 — Concentration, µg/l

ND(.2) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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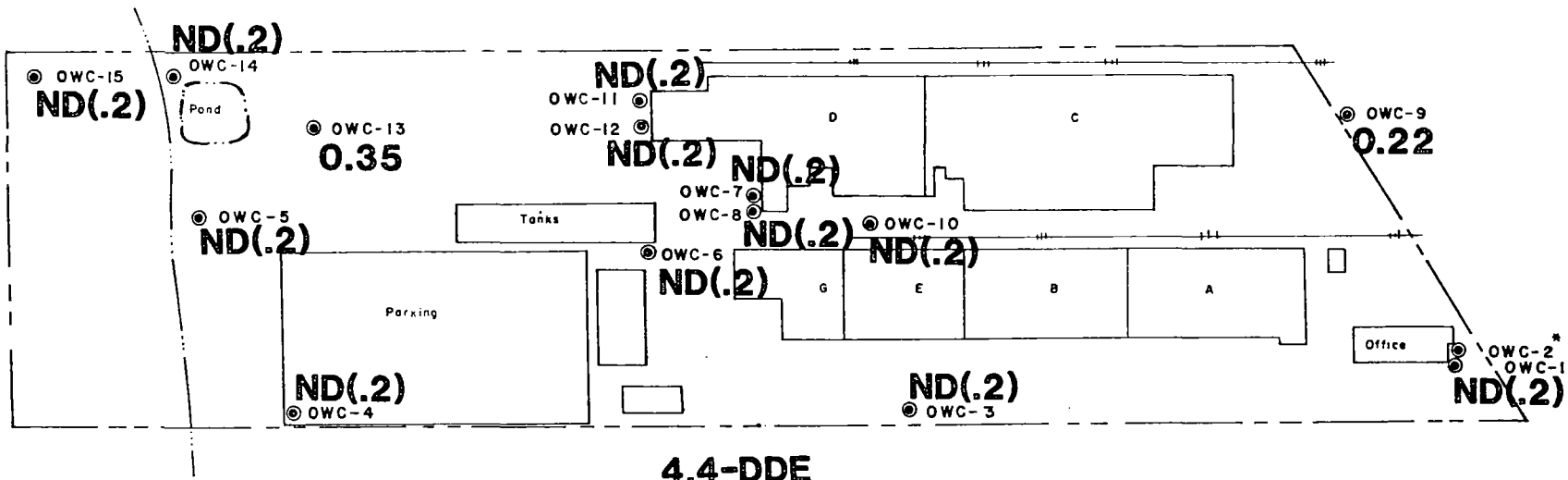
FIG. NO 10



4,4-DDE

µg/l

– WATER QUALITY ANALYSIS –

OWC-1 ◉ — Groundwater observation well

.23 — Concentration, µg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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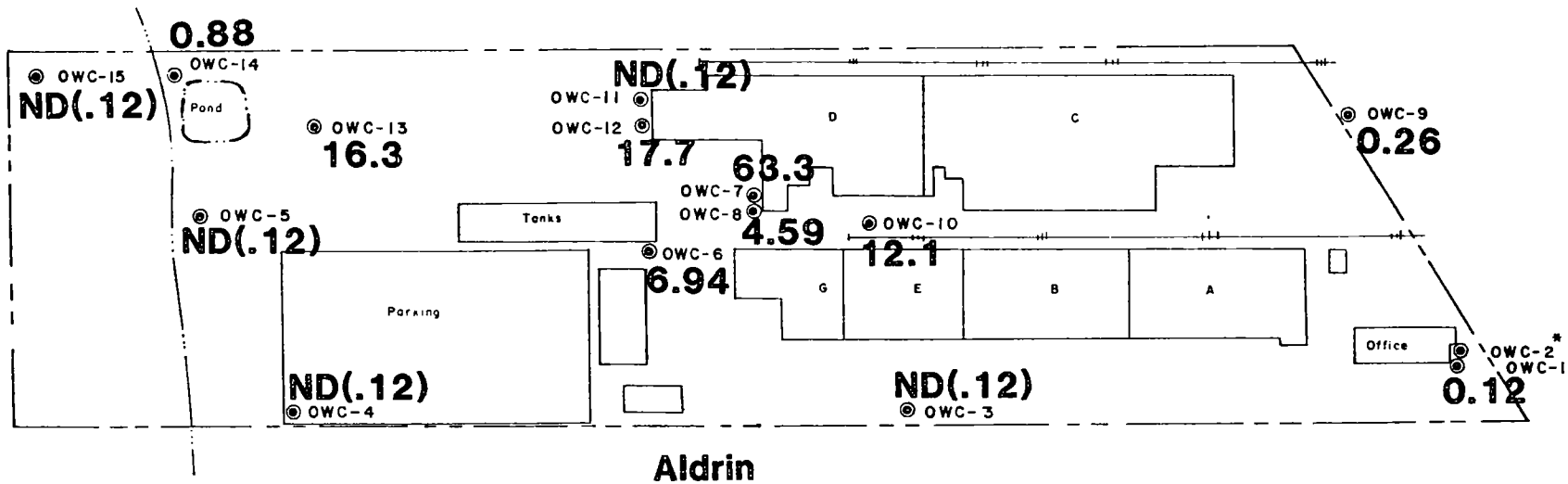
FIG NO. 11



Aldrin

µg/l

– WATER QUALITY ANALYSIS –

OWC-1 ◉ — Groundwater observation well

12.6 — Concentration, µg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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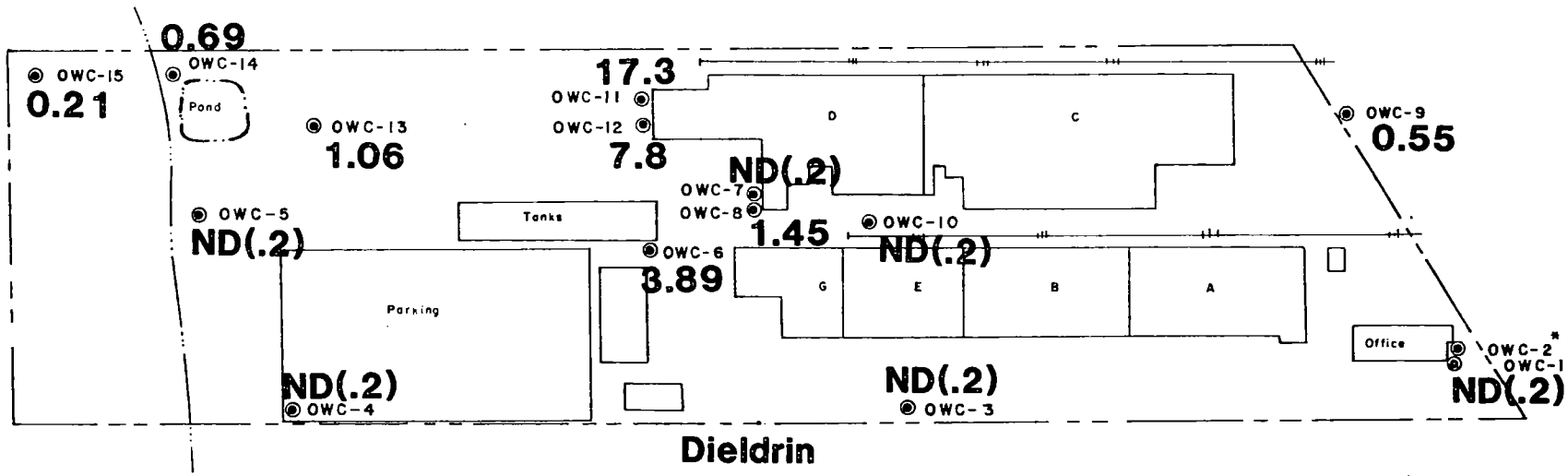
FIG NO. 12



— WATER QUALITY ANALYSIS —

OWC-1 ◉— Groundwater observation well

3.3 — Concentration, µg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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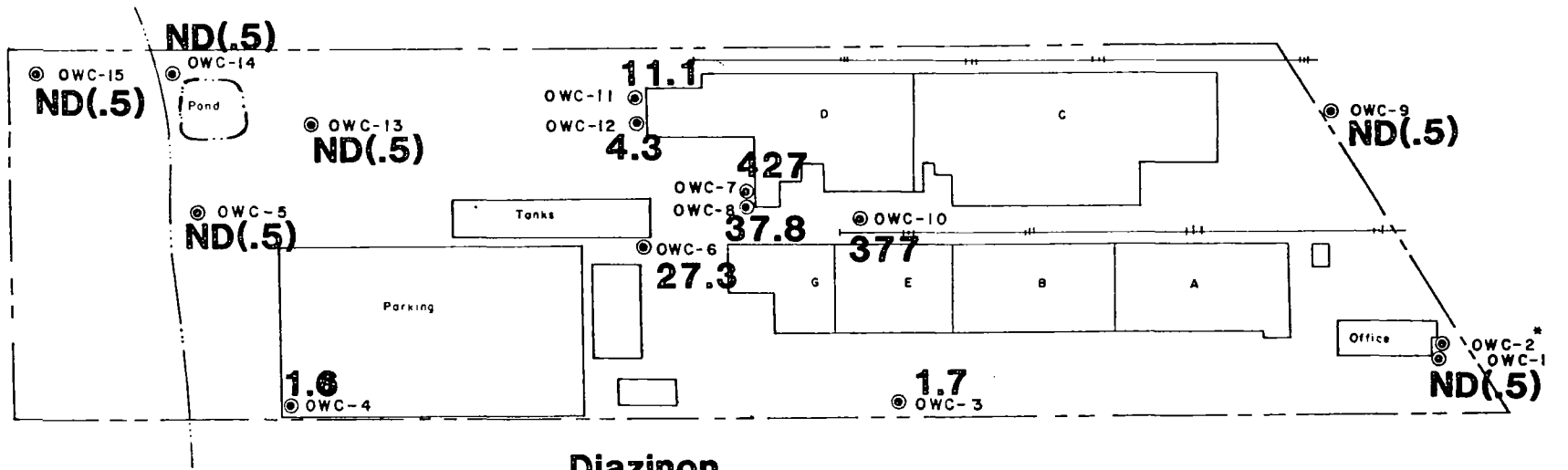
FIG NO. 13



Diazinon

µg/l

– WATER QUALITY ANALYSIS –

OWC-1 ◉— Groundwater observation well

1.6 — Concentration, µg/l

ND( )— None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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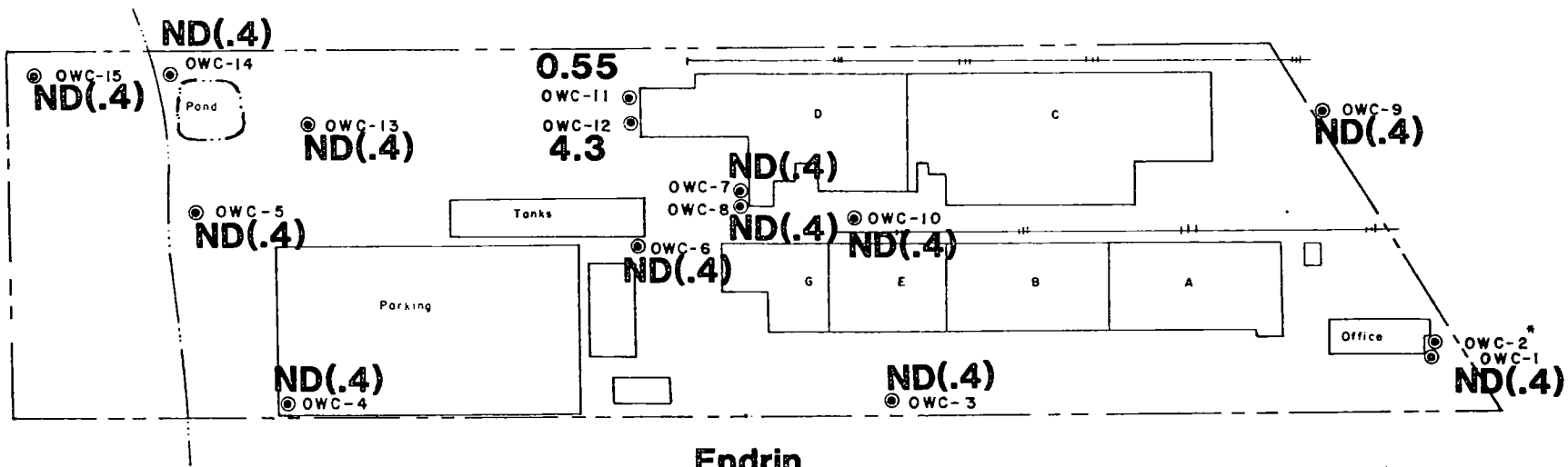
FIG NO. 14



Endrin

µg/l

– WATER QUALITY ANALYSIS –

OWC-1 ◉ — Groundwater observation well

2.11 . — Concentration, µg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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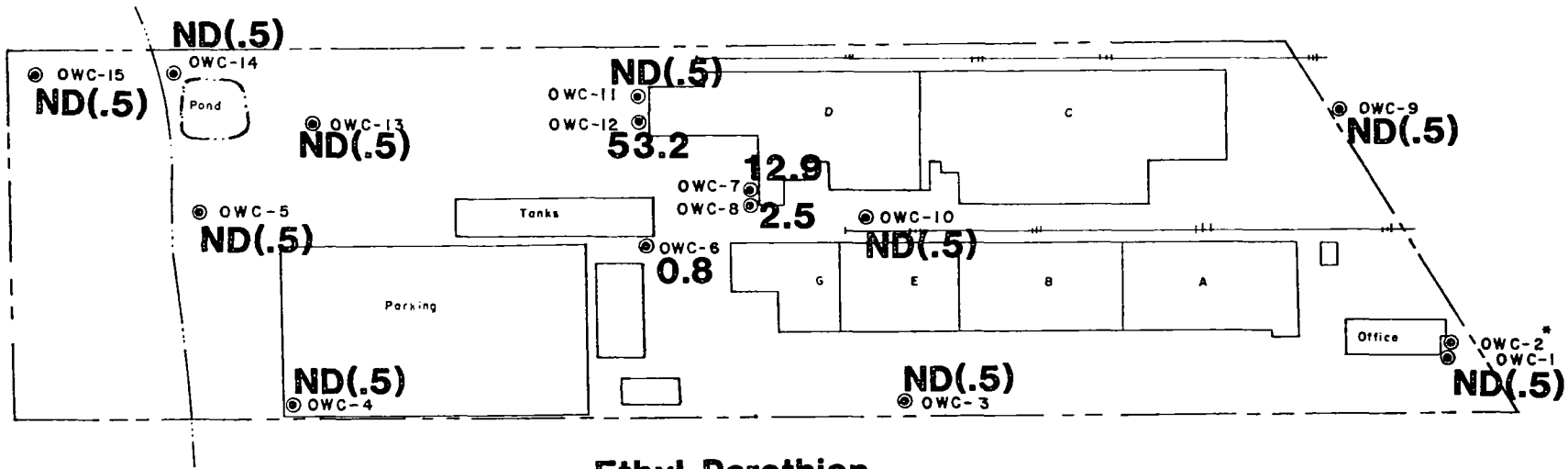
FIG NO. 15



Ethyl-Parathion

µg/l

– WATER QUALITY ANALYSIS –

OWC-1 ◉ — Groundwater observation well

0.73 — Concentration, µg/l

ND(.5) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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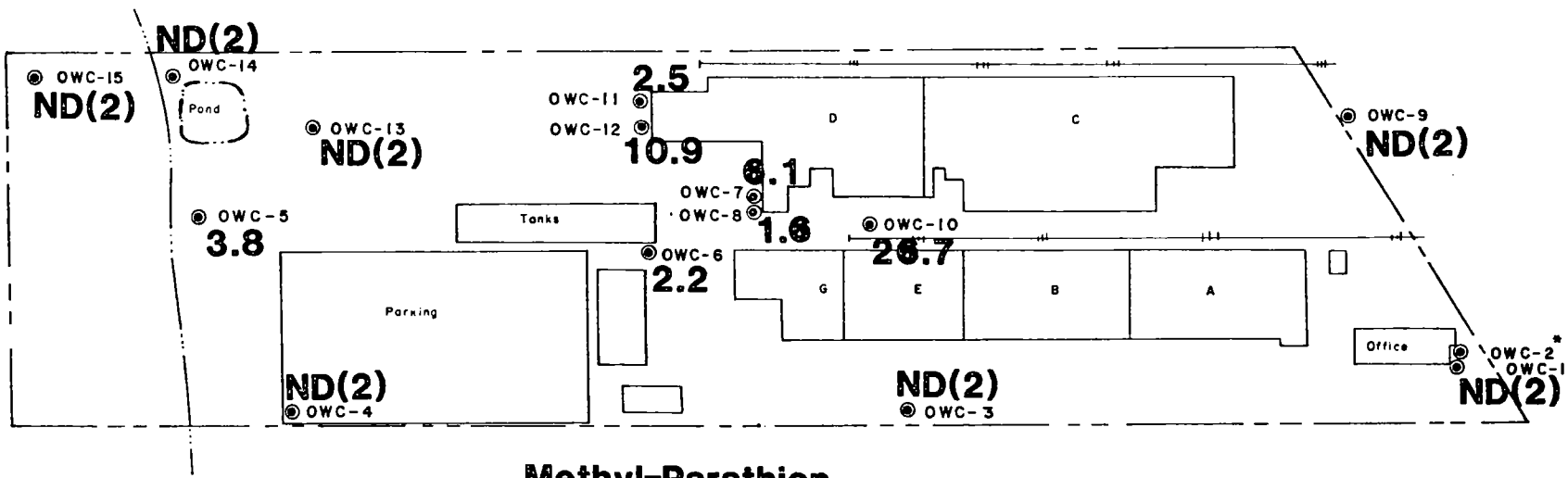
FIG NO. 16



Methyl-Parathion

µg/l

— WATER QUALITY ANALYSIS —

OWC-1 ◉ — Groundwater observation well

2.2 — Concentration, µg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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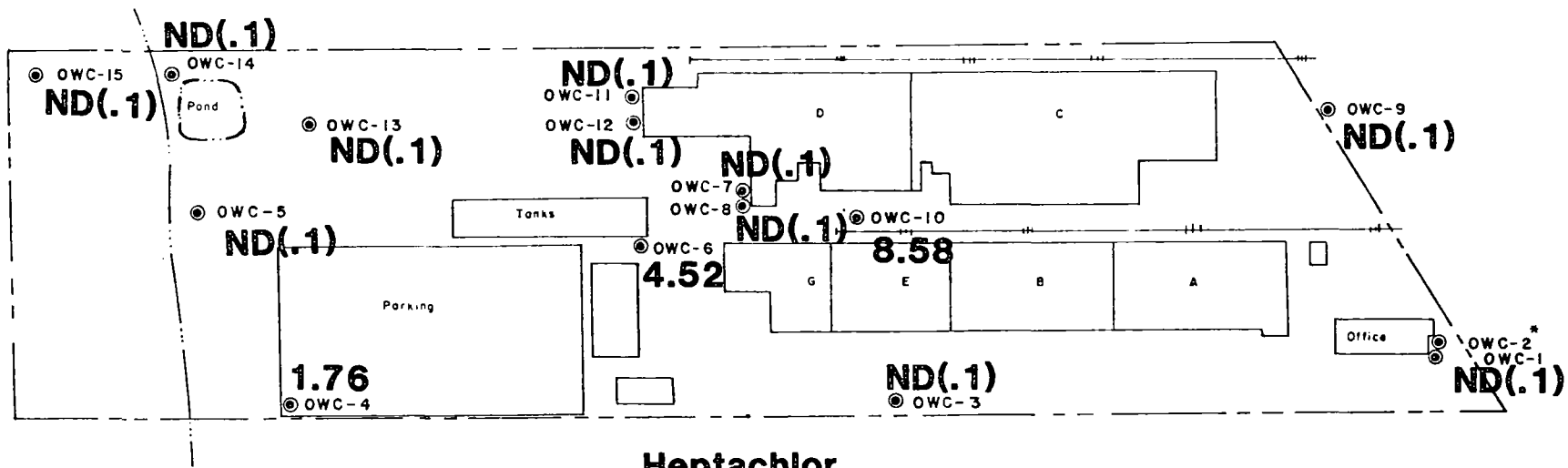
FIG. NO. 17



Heptachlor

µg / l

— WATER QUALITY ANALYSIS —

OWC-1 ◉ — Groundwater observation well

4.52 — Concentration, µg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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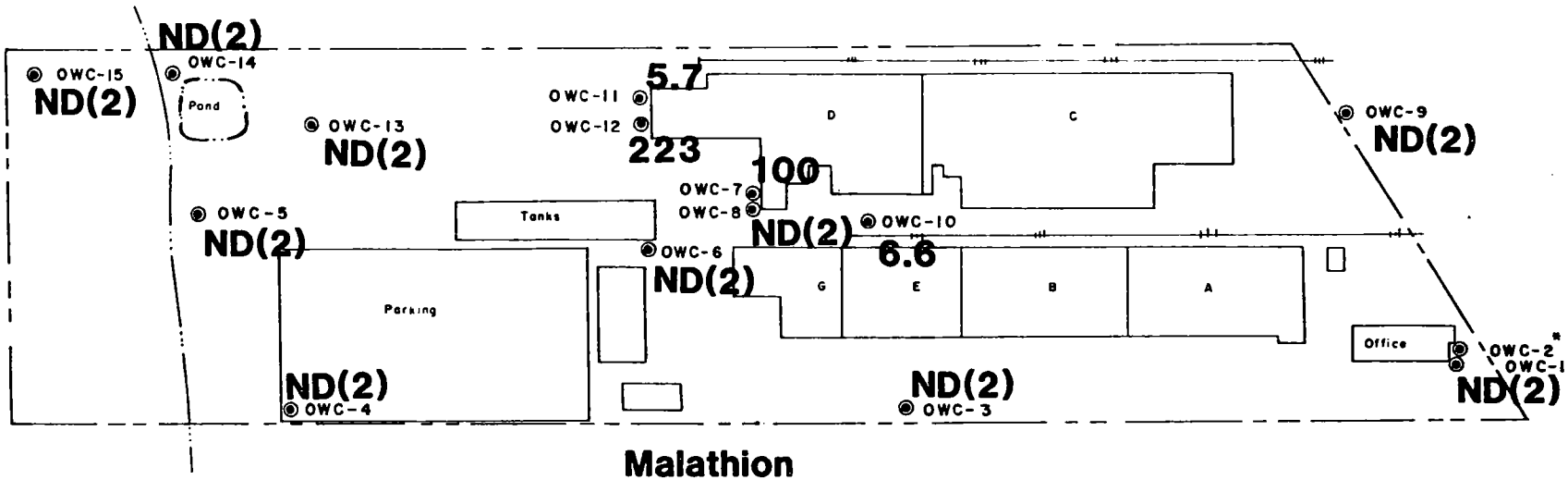
FIG NO 18



Malathion

µg/l

— WATER QUALITY ANALYSIS —

OWC-1 ◉ — Groundwater observation well

6.6 — Concentration, µg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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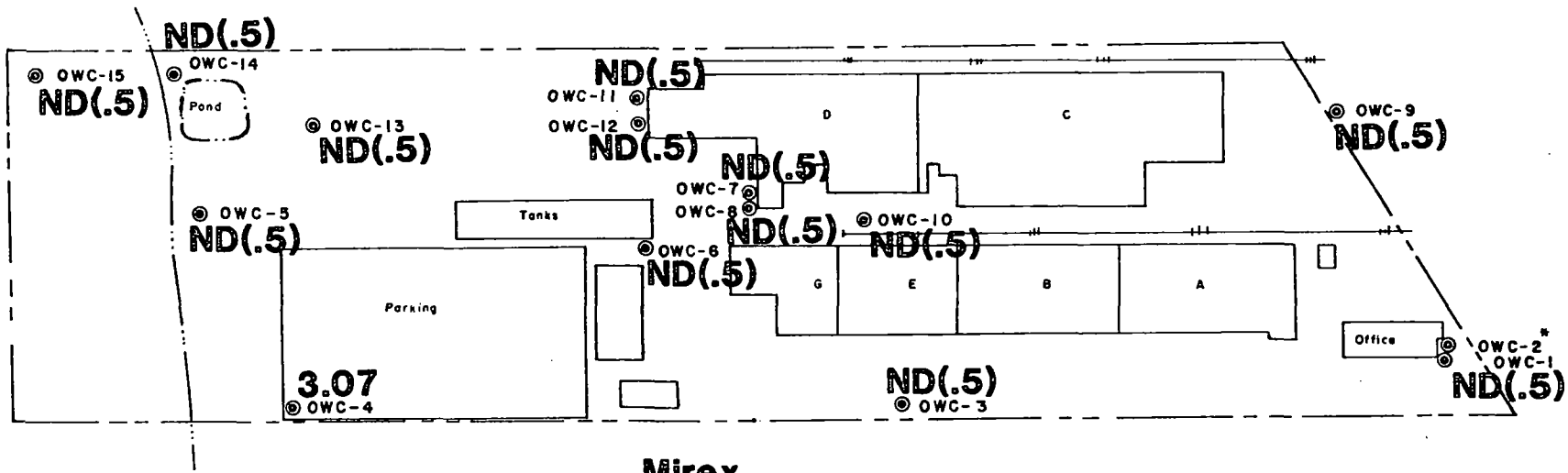
FIG NO 19



Mirex

µg/l

— WATER QUALITY ANALYSIS —

OWC-1 ◉ — Groundwater observation well

3.01 — Concentration, µg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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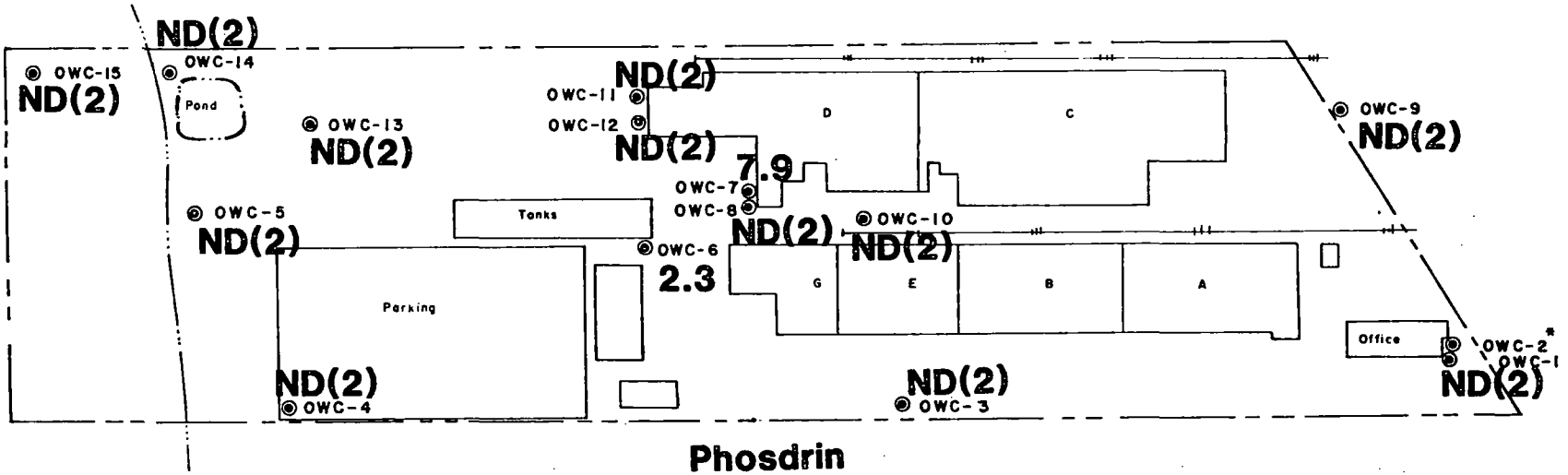
FIG NO. 20



Phosdrin

µg/l

— WATER QUALITY ANALYSIS —

OWC-1 ◉ — Groundwater observation well

2.3 — Concentration, µg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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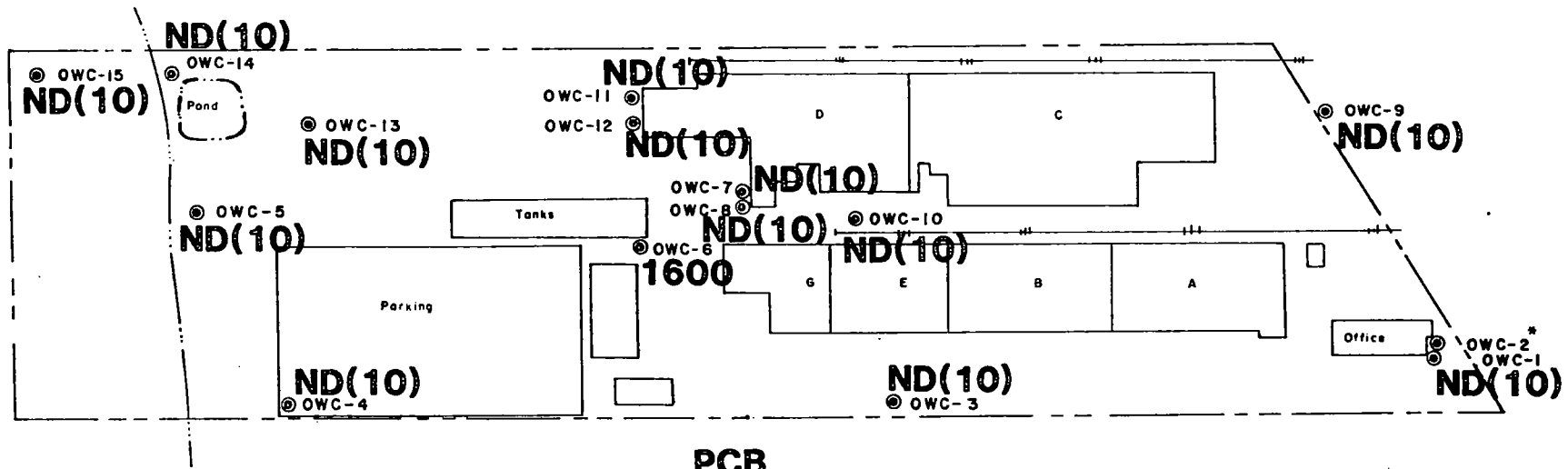
FIG. NO. 21



PCB

µg/l

– WATER QUALITY ANALYSIS –

OWC-1 ◉ — Groundwater observation well

10 — Concentration, µg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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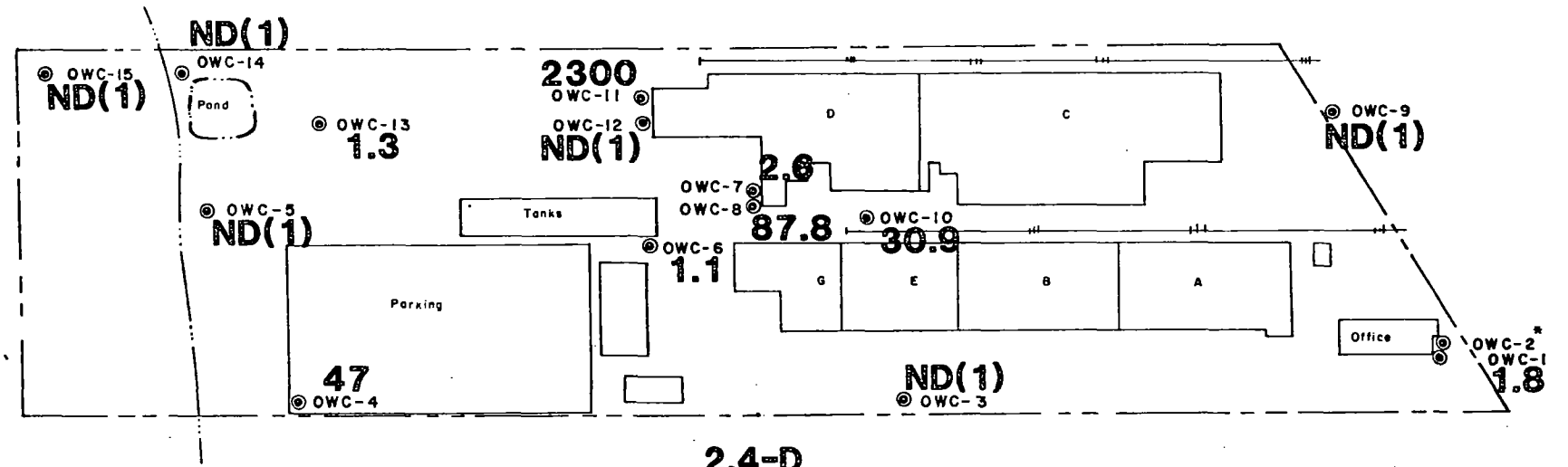
FIG NO. 22



2,4-D

µg/l

— WATER QUALITY ANALYSIS —

OWC-1 ◎ — Groundwater observation well

2.27 — Concentration, µg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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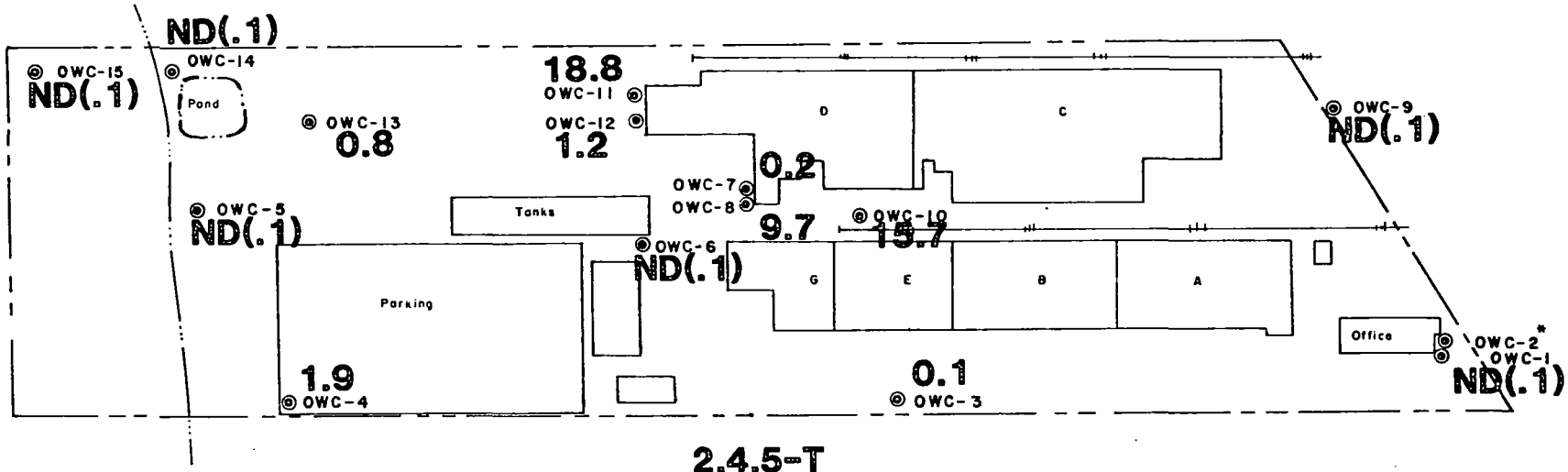
FIG. NO. 23



DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

*OWC-2 was not sampled

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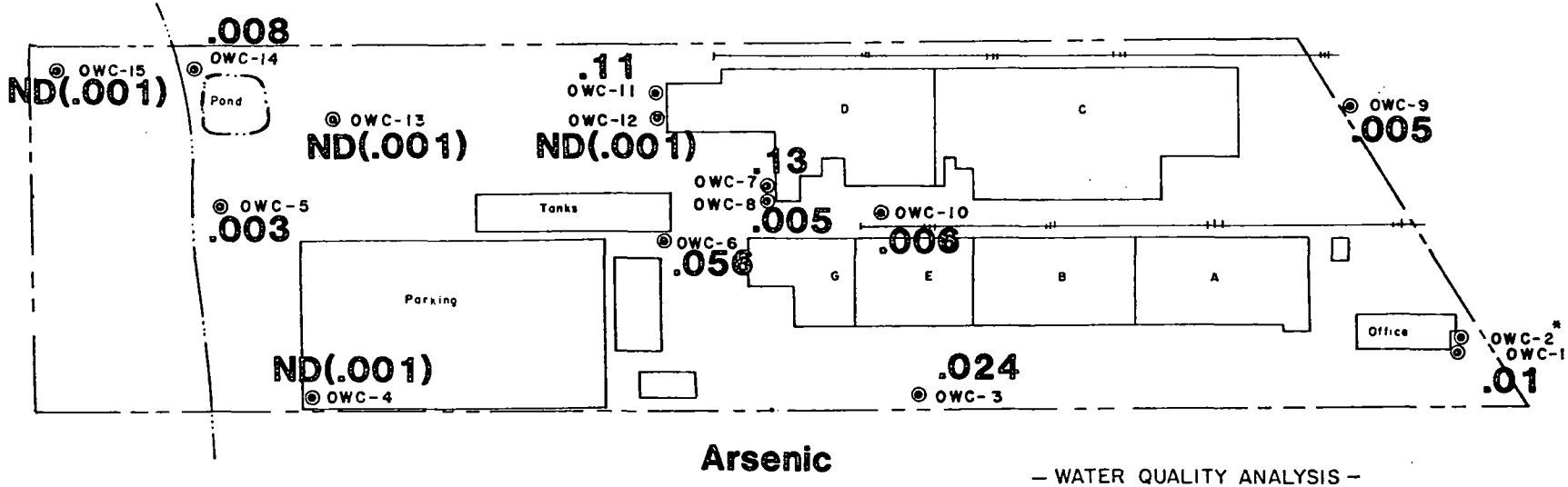
FIG NO. 24



Arsenic

mg/l

— WATER QUALITY ANALYSIS —

OWC-1 ◉— Groundwater observation well

.006 — Concentration, mg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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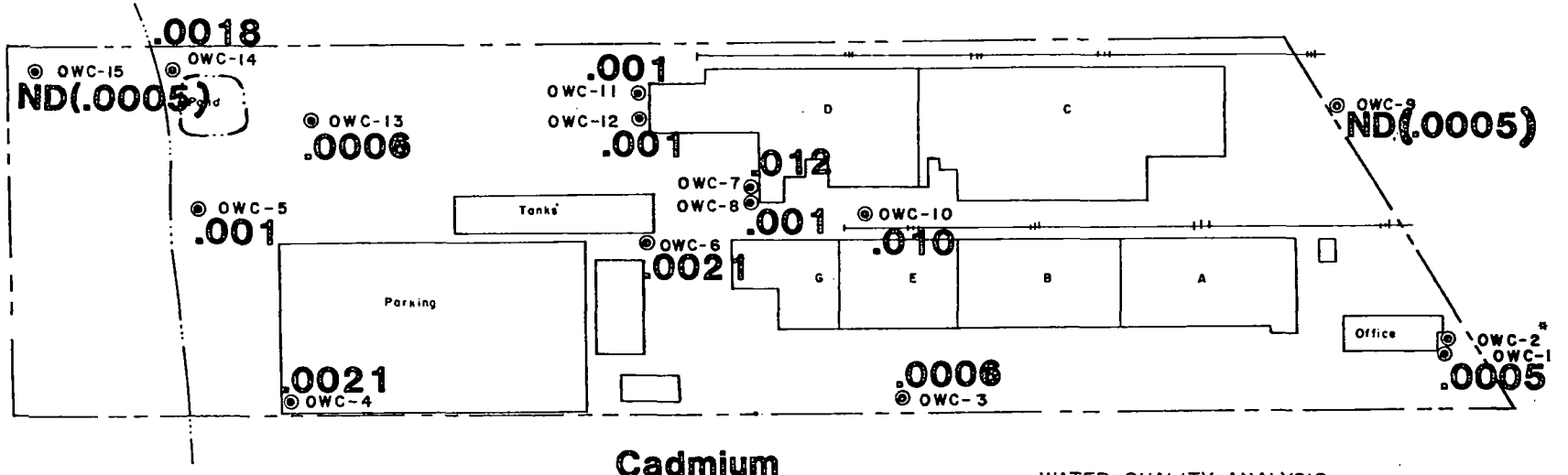
FIG. NO 25



Cadmium

mg/l

— WATER QUALITY ANALYSIS —

OWC-1 ◉— Groundwater observation well

.0007— Concentration, mg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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MARYLAND HEIGHTS, MISSOURI
ORTHO-CHEVRON CHEMICAL COMPANY

PROJECT NO. S81-5

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CENTRAL REGION

DRN. BY: RJK
CHKD. BY: [illegible]

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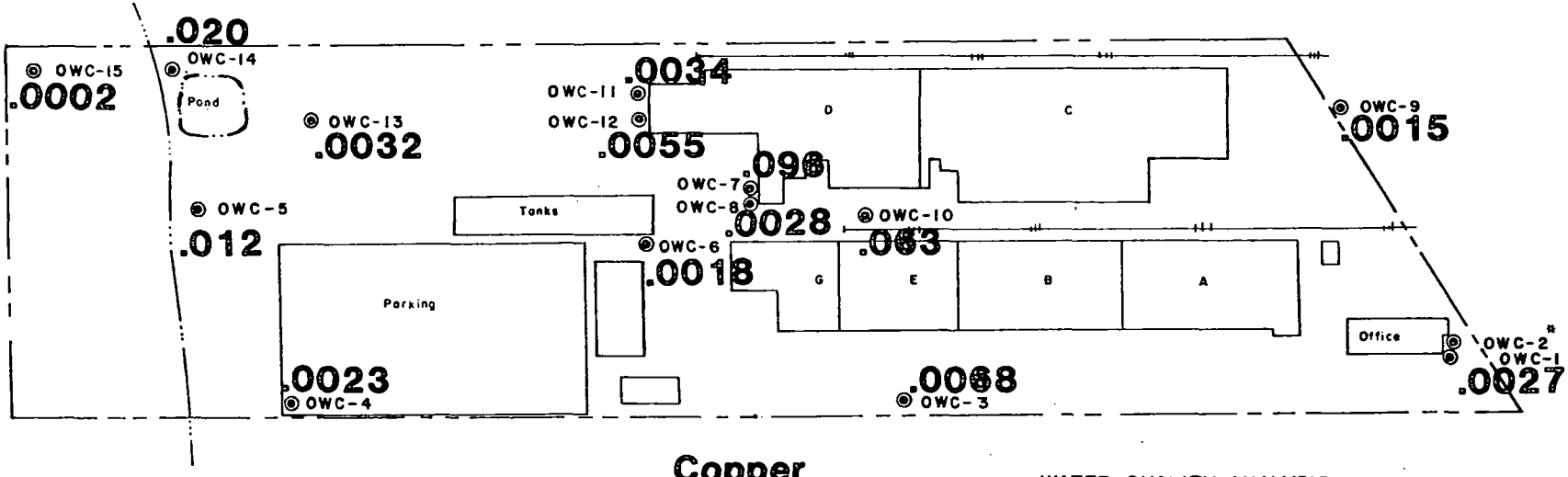
FIG. NO. 26



Copper

mg/l

– WATER QUALITY ANALYSIS –

OWC-1 ◉ — Groundwater observation well

.0013 — Concentration, mg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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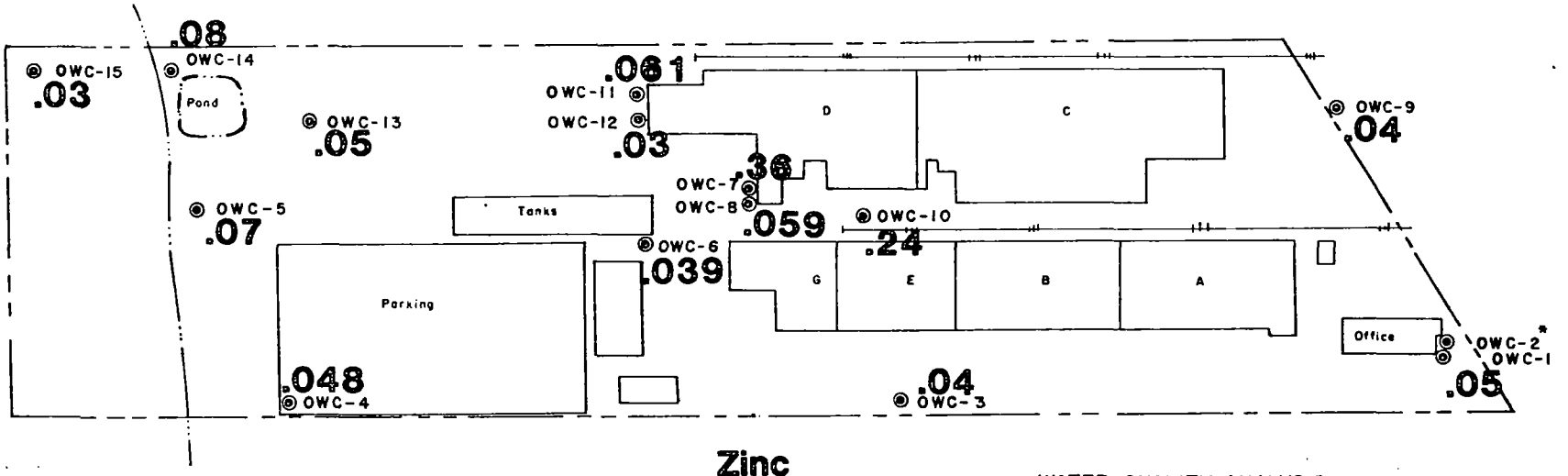
FIG NO. 27



Zinc

mg/l

– WATER QUALITY ANALYSIS –

OWC-1 ◎ — Groundwater observation well

.04 — Concentration, mg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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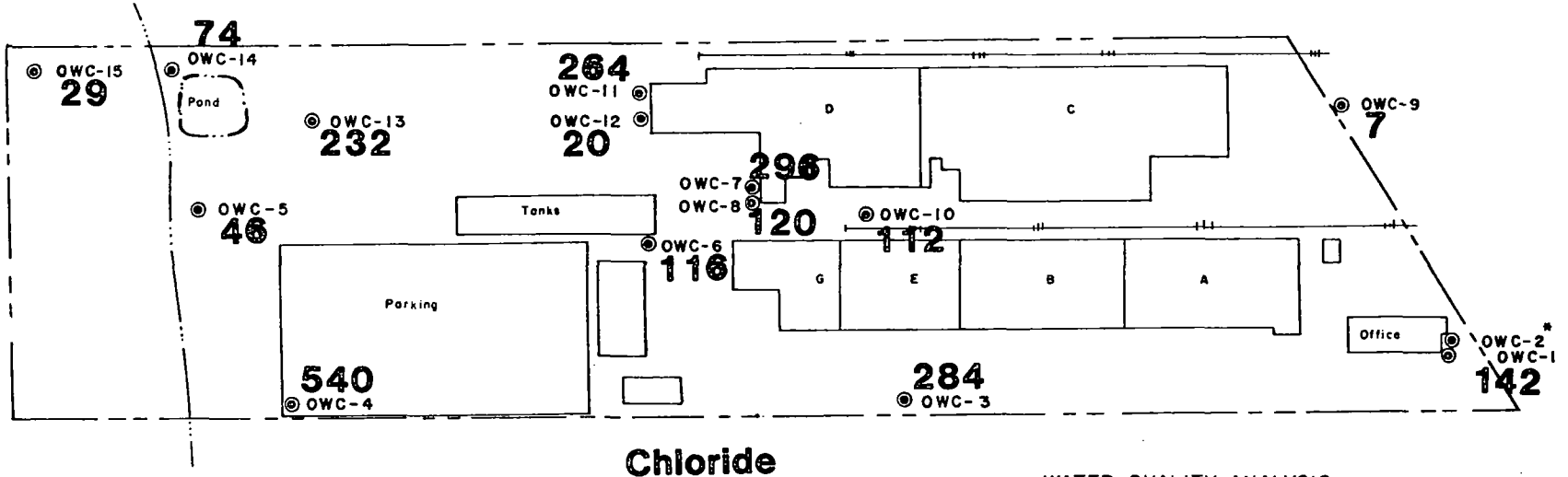
FIG NO. 28



Chloride

mg/l

— WATER QUALITY ANALYSIS —

OWC-1 ◎ — Groundwater observation well

123 — Concentration, mg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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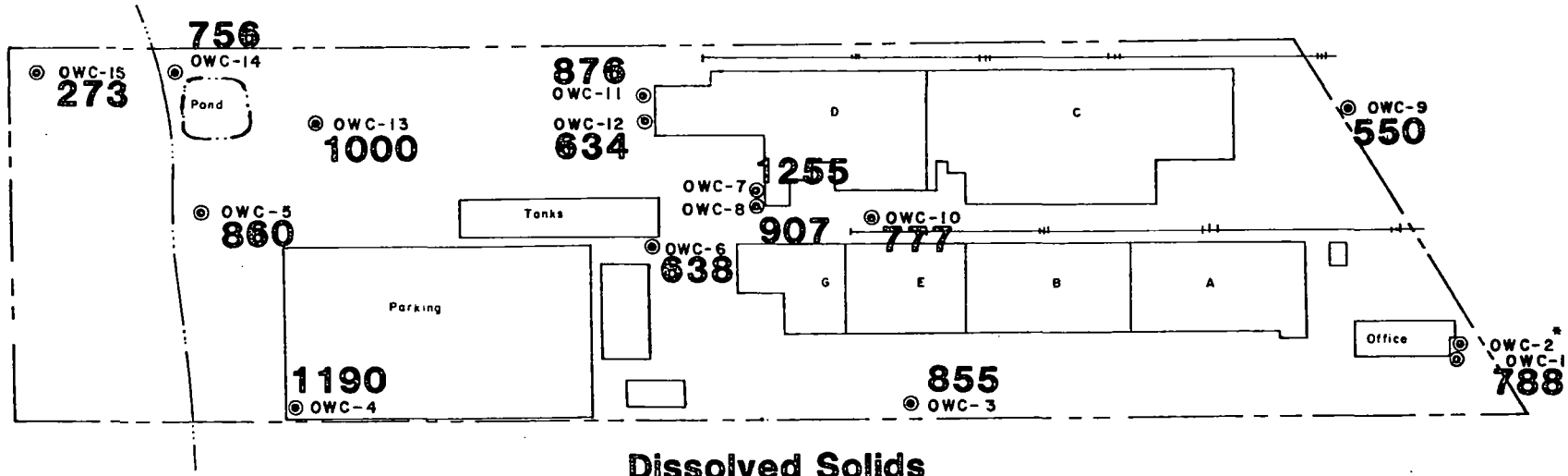
FIG NO. 29



Dissolved Solids

mg/l

— WATER QUALITY ANALYSIS —

OWC-1 ◎— Groundwater observation well

457— Concentration, mg/l

ND( )— None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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MARYLAND HEIGHTS, MISSOURI
ORTHO-CHEVRON CHEMICAL COMPANY

PROJECT NO. SB1-5

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CHKD. BY:

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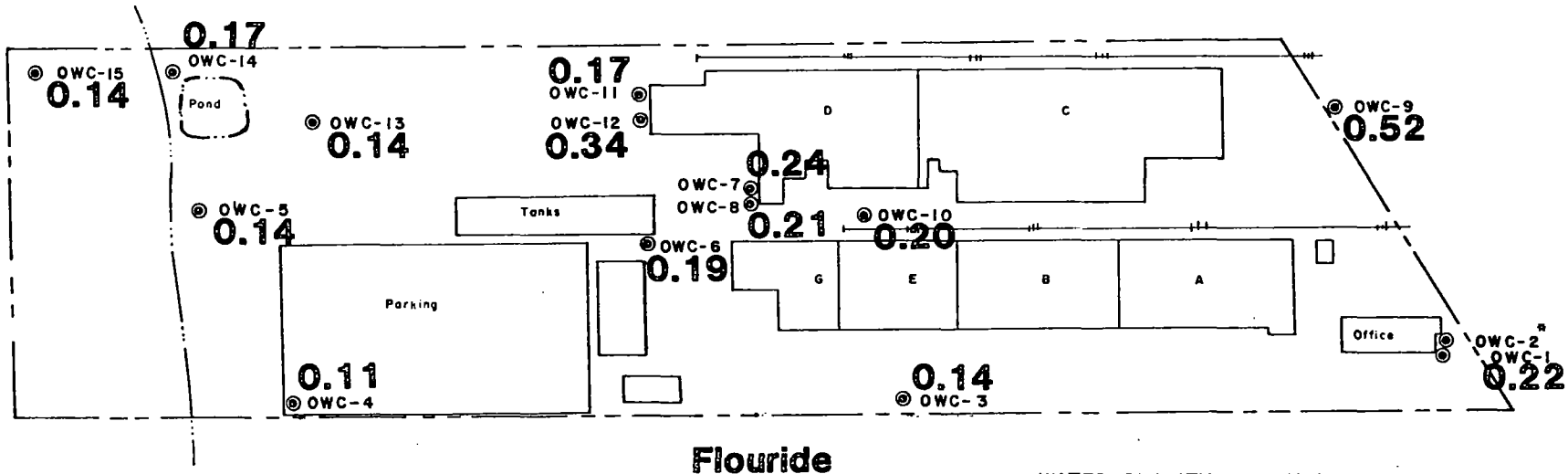
FIG. NO. 30



Flouride

mg/l

— WATER QUALITY ANALYSIS —

OWC-1 ◉— Groundwater observation well

.014 — Concentration, mg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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MARYLAND HEIGHTS, MISSOURI
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PROJECT NO. SBI-5

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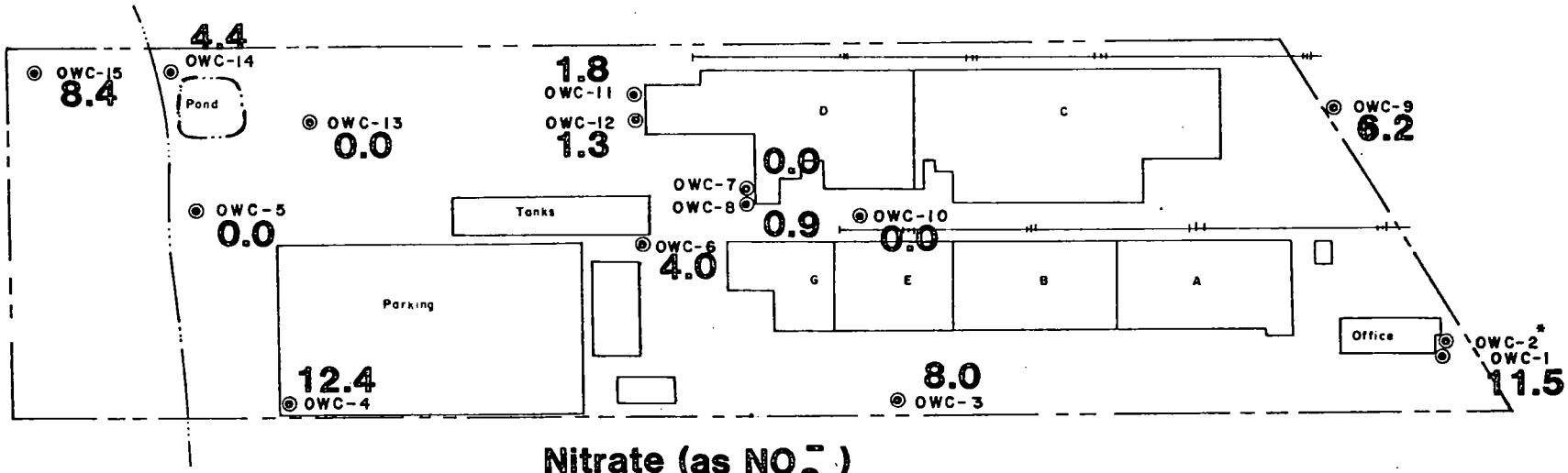
FIG NO. 31



Nitrate (as NO_3^-)

mg/l

— WATER QUALITY ANALYSIS —

OWC-1 ◎ — Groundwater observation well

1.3 — Concentration, mg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

HYDROGEOLOGY & GROUNDWATER STUDY
MARYLAND HEIGHTS, MISSOURI
ORTHO-CHEVRON CHEMICAL COMPANY

PROJECT NO. 581-5

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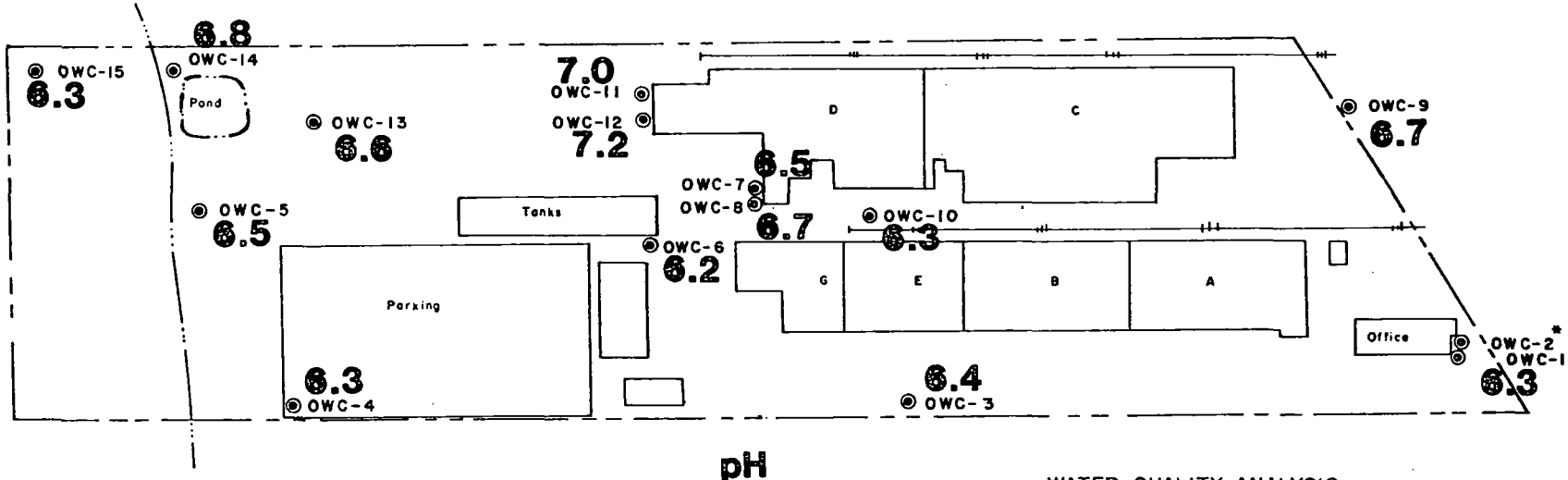
FIG. NO. 32



pH

ph units

— WATER QUALITY ANALYSIS —

OWC-1 ⊙— Groundwater observation well

6.8 — pH units

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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MARYLAND HEIGHTS, MISSOURI
ORTHO-CHEVRON CHEMICAL COMPANY

PROJECT NO. S81-5

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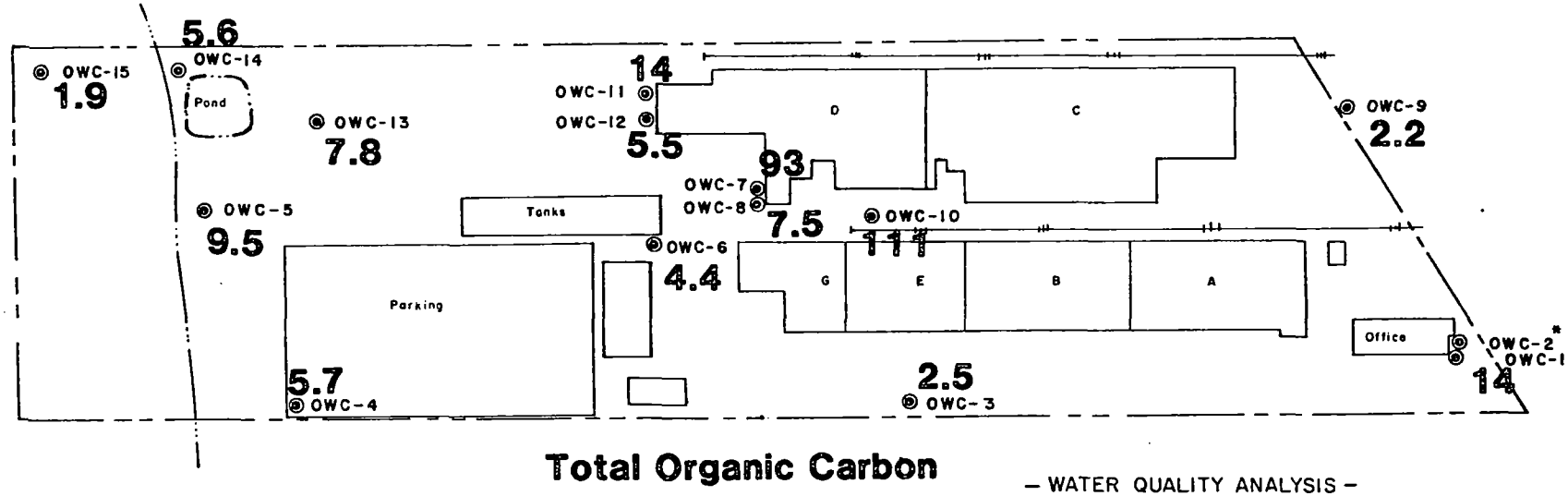
FIG. NO. 33



Total Organic Carbon

mg/l

– WATER QUALITY ANALYSIS –

OWC-1 ◎ — Groundwater observation well

2.3 — Concentration, mg/l

ND( ) — None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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MARYLAND HEIGHTS, MISSOURI
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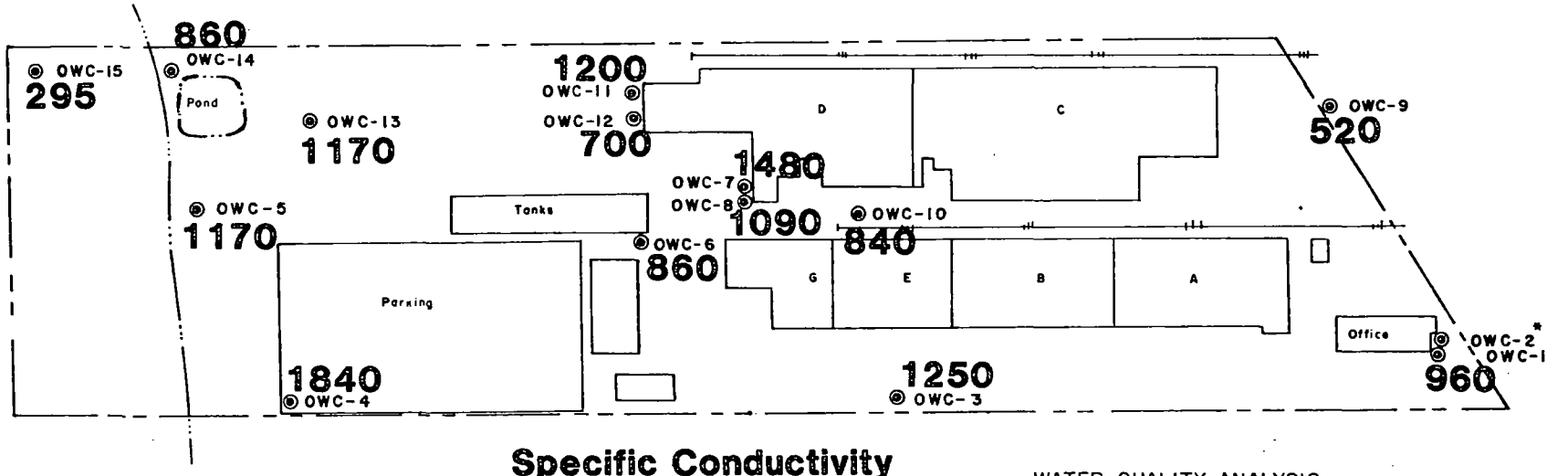
FIG. NO. 34



Specific Conductivity

μmhos/cm

– WATER QUALITY ANALYSIS –

OWC-1 ◎— Groundwater observation well

1234 — μmhos/cm

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

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PROJECT NO. S81-5

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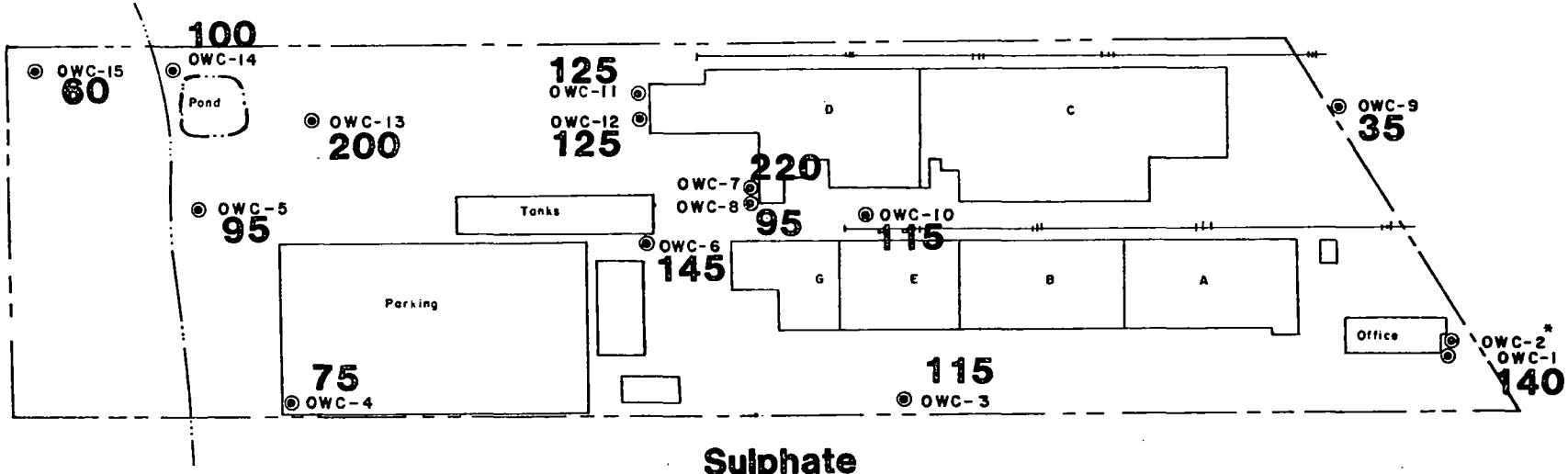
FIG NO. 35



Sulphate

mg/l

— WATER QUALITY ANALYSIS —

OWC-1 ◉— Groundwater observation well

115 — Concentration, mg/l

ND( )— None Detected (detection limit)

DEPTH of WELLS, ft

OWC-1	23
OWC-2	69.5
OWC-7	17
OWC-8	27.5
OWC-11	28
OWC-12	40.3

REMAINING WELLS VARY IN DEPTH FROM 20 to 35 FEET

N

0 50 100 200

SCALE, ft

*OWC-2 was not sampled

HYDROGEOLOGY & GROUNDWATER STUDY
MARYLAND HEIGHTS, MISSOURI
ORTHO-CHEVRON CHEMICAL COMPANY

PROJECT NO. S81-5

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FIG NO. 36

APPENDIX A

DETAILED LOGS OF BORINGS

BORING LOG

LEGEND AND NOMENCLATURE

Items shown on boring logs refer to the following:

1. Depth - Depth below reference elevation, ground surface unless otherwise shown.

2. Sample - Types designated by letter

   D - Disturbed sample, obtained from auger cuttings or wash water for classification purposes only.

   S - Split-Spoon sample, obtained by driving 2-inch split-spoon to determine penetration resistance and allow classification.

   C - Liner tube sample, obtained by penetration of thick, wall sampler containing 2-inch diameter liner-tubes (California sampler).

   U - Undisturbed sample, obtained by penetration of minimum 3 inch diameter, thin-wall tube using an open or, where indicated, fixed-piston sampling head.

   Rec - Recovery is expressed as a ratio of the length recovered to the total length pushed or driven (in inches) i.e. $\frac{8}{12}$

   Resist - Resistance is designated as follows:

   P - Sample pushed in one continuous movement by hydraulic rig action, maximum hydraulic pressure shown where pertinent.

   $^{3}6_{9}$ - Numbers indicate blows per 6 inches of sampler penetration when driven by a 140-pound hammer falling freely 30 inches. The Standard Penetration Resistance is the number of blows for the last 12 inches of penetration of the split-spoon sampler, e.g. 15. Note that a blow count can be given for the California sampler, but this is not the Standard Penetration Resistance.

3. Description - Description of material according to the Unified Soil Classification: word description gives soil constituents, consistency or density, and other appropriate classification characteristics. Unified Soil Classification symbols are shown on the USC column. Geologic names, where appropriate, are shown under Special Notes. A solid line indicates stratigraphic change; a dashed line indicates approximate location of stratigraphic change.

4. Special Notes and Field Observations - Pertinent observations made by inspector during drilling including type of boring, free water level, water seepage, fluid loss, hole termination depth, etc.

5. Legend -

CFA - Continuous flight auger
ATD - At time of drilling
AD - After drilling
DWL - Drill water loss
DWR - Drill water return

▼ Water depth at specified time after drilling

← Water entry depth at time of drilling

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/3/81

B-201

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 524 ATD

SURFACE ELEVATION 534 ELEVATION DATUM USC & GS

El 529 24 hr AD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Asphalt and Gravel FILL		Boring advanced with 6-inch diameter hollow stem auger
	C	14/18	P	Firm to stiff, brown, low plastic silty Clay FILL	FILL	
5				Firm to stiff, brown, low plastic Silty CLAY	CL	Modified loess ▼ 24 hrs AD
	C	12/18	P			
10						← ATD
	C	16/18	P	Becoming stiff, low to medium plastic with black iron deposits		
15						
	C	15/18	P	Becoming medium to highly plastic	CL-CH	
20						
	C	14/18	P	Hard, tan, brown, gray, highly plastic CLAY with trace of silt, and black iron deposits	CH	Residual
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-1

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-201

DATE 2-3-81

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 524 ATD
El 529 24 hr AD

SURFACE ELEVATION 534 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	C	10/18	P	SAME: Hard, multi-colored, highly plastic CLAY with shale fragments	CH	Auger refusal Bottom of boring 27 ft
30						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-2

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/10/81

B-202

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 513 ATD

SURFACE ELEVATION 526 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Asphalt and Gravel FILL	FILL	Boring advanced with 6-inch diameter hollow stem auger
				Stiff, brown, low plastic Clayey SILT with some root holes	CL	
	C	9/14	P			
5	C	9/14	P			
10	C	14/14	P			Modified loess
						← ATD
15	C	14/14	P			
				Very stiff, brown with gray, highly plastic Silty CLAY	CH	Transitional
20	C	14/14	P			
				Hard, gray, Shaley CLAY	CH-SH	Residual
25				SHALE: Hard, gray, weathered	SH	

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-3

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/10/81

B-202

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 513 ATD

SURFACE ELEVATION 526 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	C	7/7	P	SAME: SHALE: Hard, gray, weathered	SH	
30						Bottom of Boring 30 ft

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-4

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-203

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 1/26/81

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS None ATD

SURFACE ELEVATION 517 ELEVATION DATUM USC & GS

El 498 24 hr AD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Stiff, brown, silty Clay FILL	FILL	Boring advanced with 6-inch diameter hollow stem auger
	C	3/18	P			
	C	2/18	P	Stiff, brown, Silty CLAY	CL	
5	C	3/18	P			
10	C	2/18	P	Becoming very silty	CL-ML	Modified loess
15	C	2/18	P			
						▼ 24 hr AD
20	C	2/18	P	Very stiff, brown, Silty CLAY with sand and gravel	CH	Residual
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-5

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO-CHEVRON

PROJECT NO. S81-5

B-203

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 1/26/81

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS None ATD

SURFACE ELEVATION 517 ELEVATION DATUM USC & GS

El 498 24 hr AD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25				SAME: Very stiff, highly plastic CLAY	CH	Auger refusal
				LIMESTONE	LS	Bottom of boring 26 ft
30						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-6

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/9/81

B-204

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 489 ATD

SURFACE ELEVATION 514 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Firm to stiff, brown Clay FILL	FILL	Boring advanced with 6-inch diameter hollow stem auger
	C	11/18	P			
5				Stiff, gray and brown, low plastic Silty CLAY	CL	Stream deposit
	C	13/18	P			
	C	13/18	P	With organics		
10						
	C	13/18	P	Firm to stiff, brown, low plastic Silty CLAY		Modified loess
15						
	C	16/18	P	Becoming low to medium plastic		
20				Stiff to hard, gray, highly plastic CLAY with trace silt	CH	Residual
	C	13/18	P			
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-7

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-204

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 2/9/81

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 489 ATD

SURFACE ELEVATION 514 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	C	11/18	P	SAME: Stiff to hard, gray, highly plastic CLAY	CH	← ATD
				With rock fragments		
30						Auger refusal
				LIMESTONE	LS	Bottom of boring 31 ft

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-8

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 1/26/81

B-205

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 506 ATD
El 509 24 hr AD

SURFACE ELEVATION 516 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Stiff, brown, low plastic silty Clay FILL with cinders and gravel	FILL	Boring advanced with 6-inch diameter hollow stem auger
	C	9/18	P			
	C	13/18	P	Stiff, dark gray-brown, low plastic Silty CLAY	CL	Stream deposit
5	C	14/18	P			
	C	14/18	P	Stiff, brown, Silty CLAY		▼ 24 hrs AD Modified Loess
10	C	14/18	P			← ATD
15	C	14/18	P			
20	C	14/18	P			
25				Very stiff, brown, highly plastic Silty CLAY with rock fragments	CH	Residual

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-9

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-205

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 1/27/81

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 506 ATD

SURFACE ELEVATION 516 ELEVATION DATUM USC & GS

El 509 24 hr AD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	C	6/18	P	SAME: Very stiff, brown, highly plastic Silty CLAY with rock fragments	CH	
				LIMESTONE	LS	Bottom of Boring 28 ft
30						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-10

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/13/81

B-206

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 503 ATD

SURFACE ELEVATION 518 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				3 inches asphalt		
				Firm, brown Clay FILL with gravel and cinders	FILL	Boring advanced with 6-inch diameter hollow stem auger
	C	15/18	P			
5				Stiff, gray with brown, low plastic Silty CLAY	CL	Stream deposit
	C	12/18	P			
	C	13/18	P	Stiff, brown, low plastic Silty CLAY		Modified loess
10	C	15/18	P	Becoming low to medium plastic		
15	C	13/18	P			← ATD
				Stiff to hard, brown, highly plastic CLAY with trace silt	CH	Residual
20	C	16/18	P			
				Becoming red-purple		
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-11

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-206

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 2/13/81

LOGGED BY Peter Barrett DRILLED BY G. Johanning

RIG CME 750

SURFACE ELEVATION 518 ELEVATION DATUM USC & GS

WATER ENTERS El 503 ATD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	S	3/3	30/3	SAME: Hard, red-purple CLAY		Bottom of boring 25.3 ft Auger refusal
				LIMESTONE	LS	
30						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-12

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/2/81

B-207

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS EL 510 ATD

SURFACE ELEVATION 520 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Stiff, brown, silty Clay FILL with gravel and organics	FILL	Boring advanced with 6-inch diameter hollow stem auger Some odor
	C	14/18	P			
	C	11/18	P			
5				Firm to stiff, brown, low to medium plastic Silty CLAY	CL	
	C	10/18	P			
	C	12/18	P	With some gray		Modified loess
10						← ATD
	C	13/18	P			
15						
	C	0/18	P			
20				Becoming more tan-brown, medium plastic, with black deposits		Transitional to residual
	C	14/18	P			
25				Hard, multicolored, highly plastic CLAY with silt and fine sand	CH	Residual

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-13

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/2/81

B-207

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 510 ATD

SURFACE ELEVATION 520 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	C	7/9	P	SAME: Hard, multicolored, highly plastic CLAY with silt and fine sand with shale fragments at base	CH	Auger refusal Bottom of boring 26 ft

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-14

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-208

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 1/29/81

LOGGED BY Peter Barrett DRILLED BY G. Johanning

RIG CME 750

SURFACE ELEVATION 533 ELEVATION DATUM USC & GS

WATER ENTERS El 523 ATD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Railroad ballast	FILL	Boring advanced with 6-inch diameter hollow stem auger
	C	6/18	P	Loose, black, cinder FILL		
				Brown, low plastic, clayey Silt FILL		
	C	12/18	P			
				Becoming gray		
5						
	C	10/18	P	Becoming brown		
	C	12/18	P	Stiff, gray, low plastic, very Silty CLAY	CL	Stream deposit
10						← ATD
	C	18/18	P	Becoming brown with black organics, root holes, etc.		
15						
	C	18/18	P	Brown Silty CLAY		Modified loess
20						
	C	18/18	P	Becoming more plastic		
25				Becoming very stiff		

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-15

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-208

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 1/29/81

LOGGED BY Peter Barrett DRILLED BY G. Johanning

RIG CME 750

WATER ENTERS El 523 ATD

SURFACE ELEVATION 533 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	C	18/18	P	Very stiff, brown with gray, highly plastic CLAY	CH	Residual
30	C	17/17	P	Hard, gray with brown mottling, shaley CLAY to weathered Clayey SHALE	CH-SH	
35						Auger refusal
				LIMESTONE	LS	Bottom of Boring 35 ft

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-16

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-209

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 2/2/81

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS EL 522 ATD

SURFACE ELEVATION 530 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Ballast, loose gravel and cinder FILL	FILL	Boring advanced with 6-inch diameter hollow stem auger
	C	10/18	P	Stiff, gray, silty Clay FILL with organics and rock fragments		With odor
	C	14/18	P			
5				Stiff, brown and gray, low plastic Silty CLAY with organics	CL	Stream deposit
	C	13/18	P	Without organics		With root holes, iron stains
	C	14/18	P	Becoming gray with brown, more silty		← ATD
10						Modified loess
	C	14/18	P	Firm to stiff, gray, low plastic Silty CLAY		
15				Becoming brown-gray		
	C	14/18	P			
				Very stiff, brown-tan-brown, highly plastic CLAY with trace silt, black deposits	CH	Transitional to residual
20	C	10/18	P			
				Stiff, light brown, low to medium plastic Silty CLAY	CL	
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-17

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-209

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 2/2/81

LOGGED BY Peter Barrett DRILLED BY G. Johanning

RIG CME 750

SURFACE ELEVATION 530 ELEVATION DATUM USC & GS

WATER ENTERS El 522 ATD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	C	16/15	P	SAME: Stiff, light-brown, low to medium plastic, Silty CLAY	CL	
				Hard, varicolored, highly plastic CLAY	CH	Residual
30	C	11/18	P			
35						Auger refusal
				LIMESTONE	LS	Bottom of Boring 35.5 ft
40						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-18

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 1/30/81

B-210

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 519 ATD

SURFACE ELEVATION 529 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Loose ballast and Cinder FILL	FILL	Boring advanced with 6-inch diameter hollow stem auger
				Stiff, black, organic, silty CLAY FILL		With odor
	C	13/18	P			
5	C	14/18	P			
	C	14/18	P			
	C	14/18	P			
				Stiff, black, gray and brown, organic Silty CLAY	CL-OL	Stream deposit
10	C	14/18	P			
				Stiff, brown, Silty CLAY, organically stained	CL	← ATD
15	C	13/18	P			
				Firm, black, organic, Silty CLAY with vegetation	OL-CL	
20	C	15/18	P			
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-19

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-210

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 1/30/81

LOGGED BY Peter Barrett DRILLED BY G. Johanning

RIG CME 750

SURFACE ELEVATION 529 ELEVATION DATUM USC & GS

WATER ENTERS El 519 ATD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	C	14/18	P	SAME: Firm, gray, organic Silty CLAY	OL-CL	
						Some odor
30	C	14/18	P	Very stiff, greenish-gray, Silty CLAY with fine sand	CL w/ SM	
35						
						Residual
				Stiff, reddish-brown, highly plastic CLAY with limestone fragments	CH	
40						Bottom of Boring 40 ft
45						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-20

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-211

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 1/29/81

LOGGED BY Peter Barrett DRILLED BY G. Johanning

RIG CME 750

SURFACE ELEVATION 528 ELEVATION DATUM USC & GS

WATER ENTERS El 526

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Loose, black, cinder FILL	FILL	Boring advanced with 6-inch diameter hollow stem auger
	C	14/18	P			← ATD
				Stiff, gray-green Clay FILL with bricks and organics		With odor
	C	13/18	P			
5						
	C	6/18	P	Becoming gray-black		
					CL	Stream deposit
	C	10/18	P	Stiff, gray, Silty CLAY with brown organics		
10						
	C	10/18	P			
15						
	C	18/18	P	Becoming more brown with small black organics		
				Very stiff, brown, highly plastic CLAY	CH	Residual
20						
	C	18/18	P			
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-21

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-211

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 1/29/81

LOGGED BY Peter Barrett DRILLED BY G. Johanning

RIG CME 750

SURFACE ELEVATION 523 ELEVATION DATUM USC & GS

WATER ENTERS El 526

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	C	18/18	P	SAME: Very stiff, gray-brown, highly plastic CLAY with orange mottling	CH	
30	S	3/6	30	SANDSTONE: Fine to medium grained, moderately cemented	SS	Bottom of Boring 30.5 ft
35						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-22

BORING LOG

SHEET 1 OF 1

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-212

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 2/24/81

LOGGED BY Peter Barrett DRILLED BY G. Johanning

RIG CME 750

SURFACE ELEVATION 514 ELEVATION DATUM USC & GS

WATER ENTERS El 494 ATD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Firm, black, silty Clay FILL with organics and rock fragments (Ramp to center of pond)	FILL	Boring advanced with 6-inch diameter hollow stem auger
						Stream deposit
	C	10/18	P	Firm to stiff, dark gray, low plastic CLAY with organics	CL	With odor
5						
	C	12/18	P			
	C	11/18	P	Without organics, medium plastic		
10				Becoming low plastic		
	C	12/18	P			
	C	15/18	P			Slight odor
15				Firm to stiff, brown, low plastic Silty CLAY	CL	Modified loess
	C	14/18	P			
20				Becoming medium to highly plastic	CL-CH	← ATD
	C	15/18	P	Stiff to hard, tan-brown, highly plastic CLAY with trace silt and iron deposits	CH	Residual
						Bottom of Boring 21.5 ft
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-23

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-213

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 1/26/81

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 498 ATD

SURFACE ELEVATION 513 ELEVATION DATUM USC & GS

El 505 24 hr AD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Stiff, brown, low to medium plastic silty Clay FILL	FILL	Boring advanced with 6-inch diameter hollow stem auger
	C	2/18	P			
				Stiff, light gray, Silty CLAY	CL	Stream deposit
	C	3/18	P			
						Organically stained
5	C	3/18	P	Becoming dark gray-brown		
						▽ 24 hrs AD
				Stiff, brown, low to medium plastic Silty CLAY		Modified loess
10	C	3/18	P			
				Very stiff brown, highly plastic Silty CLAY	CH	
15	C	8/18	P			← ATD
						Residual
20	C	8/18				
				Very stiff, purple, highly plastic CLAY with shaley zones	CH-SH	
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-24

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-213

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 1/26/81

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 498 ATD

SURFACE ELEVATION 513 ELEVATION DATUM USC & GS

El 505 24 hrs AD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	C	6/18	P	SAME: Very stiff, highly plastic CLAY with shale fragments	CH-SH	
				LIMESTONE: Weathered	LS	Auger refusal Bottom of Boring 26.11
30						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-25

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-214

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 1/30/81

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 530 ATD

SURFACE ELEVATION 534 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Loose, cinder FILL	FILL	Boring advanced with 6-inch diameter hollow stem auger
				Stiff, gray, clayey Silt FILL with cinders		With odor
	C	16/18	P			
				Becoming brown and high plastic		← ATD
	C	12/18	P	Stiff, gray, low plastic Silty CLAY with organics	CL	
5						
	C	13/18	P			Pond deposit
	C	14/18	P	Stiff, brown, low plastic Silty CLAY		Modified loess
10						
	C	13/18	P			
15				Becoming low to medium plastic		
	C	15/18	P			
20				Becoming light gray and brown, medium plastic		
	C	14/18	P			
25				Very stiff, brown and gray, medium to highly plastic CLAY with silt	CL | CH	

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-26

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-214

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 1/30/81

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 530 ATD

SURFACE ELEVATION 534 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	C	14/18	P	SAME: Very stiff, brown and gray medium to highly plastic CLAY with trace silt	CL I CH	Residual
30						
35						
40				LIMESTONE	LS	Bottom of Boring 40 ft
45						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-27

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-215

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 3/2/81

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 513 ATD

SURFACE ELEVATION 523 ELEVATION DATUM USC & GS

El 516 24 hrs AD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Firm to stiff, brown, silty Clay FILL with organics	FILL	Boring advanced with 6-inch diameter hollow stem auger
	C	14/16	P			
	C	14/16	P			
5	C	12/16	P			
				Firm to stiff, brown, low to medium plastic Silty CLAY	CL	Modified loess
	C	14/16	P			▼ 24 hrs AD
10	C	15/16	P			← ATD
15	C	14/16	P	Becoming stiff, dark brown, medium plastic with black ferrous deposits		
				Stiff, dark brown, medium to highly plastic CLAY	CH	
20	C	14/18	P			Residual
				Becoming shaley, with fine sand Becoming hard	CH SM	
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-28

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 3/2/81

B-215

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 513 ATD

SURFACE ELEVATION 523 ELEVATION DATUM USC & GS

El 516 24 hrs AD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	C	7/12	P	SAME: Hard, varicolored, Sandy SILT with trace highly plastic clay and shale fragments	ML	
30						Auger refusal
				LIMESTONE	LS	Bottom of Boring 31 ft
35						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-29

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/23/81

B-216

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 512 ATD

SURFACE ELEVATION 518 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Firm to stiff, brown silty Clay FILL with organic fragments	FILL	Boring advanced with 6-inch diameter hollow stem auger
	C	9/18	P			
	C	12/18	P			
5						
	C	11/18	P	Firm to stiff, gray Silty CLAY	CL	← ATD Stream deposit Slight odor
	C	13/18	P			
10				With tan-brown		
	C	14/18	P			
	C	14/18	P	Firm to stiff, brown Silty CLAY with some gray		Modified loess
15						
	C	16/18	P			
				Becoming low to medium plastic		
20				Stiff to hard, tan-brown highly plastic CLAY with trace silt	CH	Residual
	C	15/18	P			
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-30

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-216

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 2/23/81

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 512 ATD

SURFACE ELEVATION 518 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25				SAME: Stiff to hard, highly plastic CLAY Becoming purple	CH	Auger refusal
				LIMESTONE	LS	Bottom of Boring 26.5 ft
30						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-31

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-217

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 2/9/81

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 501 ATD

SURFACE ELEVATION 516 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Loose, black and dark red-brown Cinder FILL	FILL	Boring advanced with 6-inch diameter hollow stem auger
	C	10/18	P			Strong odor
	C	7/18	P	Stiff, gray, low plastic Silty CLAY with organics	CL	Stream deposit
5						
	C	11/18	P	Becoming green-gray		
				Stiff, brown, low plastic Silty CLAY		Modified loess
10						
	C	13/18	P	With some organics		
15						← ATD
	C	11/18	P			
20						
	C	10/18	P	Hard, tan-brown, highly plastic CLAY with iron deposits	CH	Residual
25				Becoming purple		

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-32

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-217

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 2/9/81

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 501 ATD

SURFACE ELEVATION 516 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25				SAME: Hard, purple-brown, highly plastic CLAY	CH	
				LIMESTONE	LS	Bottom of Boring 25.5 ft
30						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-33

BORING LOG

SHEET 1 OF 1

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-218

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 2/23/81

LOGGED BY Peter Barrett DRILLED BY B. Johanning

RIG CME 750

SURFACE ELEVATION 519 ELEVATION DATUM USC & GS

WATER ENTERS EL 512 ATD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Firm to stiff, brown silty Clay FILL with organics and rock fragments	FILL	Boring advanced with 6-inch diameter hollow stem auger
	C	10/18	P			Some auger
5				Firm to stiff, gray, medium plastic Silty CLAY with organics	CL	Stream deposit
	C	12/18	P			
				Firm to stiff, brown, low plastic Silty CLAY		← ATD
						Modified loess
	C	14/18	P			
10						
15				Becoming low to medium plastic		
	C	15/18	P			
				Stiff to hard, light tan-brown and gray highly plastic CLAY with trace silt	CH	Residual
20	C	13/18	P			Bottom of Boring 20 ft
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-34

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-219

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 1/27/81

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 512 ATD

SURFACE ELEVATION 527 ELEVATION DATUM USC & GS

Hole caved 24 hrs AD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Ballast and loose Gravel FILL	FILL	Boring advanced with 6-inch diameter hollow stem auger
	C	10/18	P	Stiff, brown, low plastic silty Clay FILL		
	C	8/18	P			
5						
	C	14/18	P			
				Stiff, brown, low to medium plastic Silty CLAY	CL	Modified loess
10						
	C	14/18	P			
15						← ATD
	C	16/18	P			
20						
	C	12/18	P			
				Becoming more plastic		
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-35

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

B-219

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 1/27/81

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 512 ATD

SURFACE ELEVATION 527 ELEVATION DATUM USC & GS

Hole caved 24 hrs AD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	C	12/18	P	SAME: Stiff, brown, medium plastic Silty CLAY	CL	
				Stiff, gray, brown and purple, highly plastic CLAY with chert fragments and trace silt	CH	Residual
30	C	7/18	P			
						Bottom of Boring 31.5 ft
35						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-36

BORING LOG

SHEET 1 OF 1

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

OWC-1

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 2/18/81

RIG CME 750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS None detected ATD

SURFACE ELEVATION 541 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Firm to stiff, brown, low plastic, Silty CLAY	CL	Boring advanced with 6-inch diameter hollow stem auger, lower 5-feet 8-inch diameter
5						Modified loess
10				Becoming medium plastic		
15				Hard, tan-brown, highly plastic CLAY with trace of silt	CH	Residual
20				Becoming multi-colored with shaley sections		
25						Bottom of Boring 23 ft

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-37

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/17/81

RIG CME 750

WATER ENTERS None detected ATD

OWC-2

PROJECT LOCATION ST. LOUIS, MISSOURI

LOGGED BY Peter Barrett DRILLED BY G. Johanning

SURFACE ELEVATION 541 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Firm to stiff, brown, low plastic Silty CLAY	CL	Boring advanced with 6-inch diameter hollow stem auger Lower 5 ft 8-inch diameter Modified loess
	C	15/18	P			
5	C	15/18	P			
10				With iron staining		
	C	14/18	P			
15				Becoming medium plastic		
	C	15/18	P			
				Hard, tan-brown, highly plastic CLAY with trace silt	CH	Residual
20	C	15/18	P	With blue-gray color also		
25				Hard, multi-colored, highly plastic CLAY with shaley sections	CH w/ SH	

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-38

BORING LOG

SHEET 2 OF 3

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/17/81

OWC-2

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME-750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS None detected ATD

SURFACE ELEVATION 541 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	C	13/18	P	SAME: Hard, multi-colored, highly plastic CLAY with shaley sections	CH-SH	
30	C	7/17	P			
35	C	6/6	P	Becoming predominantly gray, with fine sand		
40						
45				LIMESTONE: Gray, poorly cemented	LS	
				SHALE: Gray	SH	
50						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-39

BORING LOG

SHEET 3 OF 3

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

OWC-2

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 2/17/81

RIG CME-750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS None detected ATD

SURFACE ELEVATION 541 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
50				SAME: SHALE: gray	SH	
				Becoming purple and calcareous		
55						
60						Auger refusal 61.5
	CORE RUN 1	4/4	4/4	CHERT with some pyrite and some small 1/8 inch diameter solution holes	LS	Boring continued with NX Core Barrel with diamond bit and water
	CORE RUN 2	56/56	56/56	LIMESTONE: Light gray, unweathered, massive bedded		Run 1 Start: 61.5 Stop: 61.8 Rec: 100% DWR: 100%
65						Run 2 Start: 61.8 Stop: 66.5 Rec: 100% DWR: 100%
	CORE RUN 3	36/36	36/36			Run 3 Start: 66.5 Stop: 69.5 Rec: 100% DWR: 100%
70						Bottom of Boring 69.5 ft
75						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-40

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

OWC-3

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 2/16/81

LOGGED BY Peter Barrett DRILLED BY G. Johanning

RIG CME-750

SURFACE ELEVATION 529 ELEVATION DATUM USC & GS

WATER ENTERS El 527 ATD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Firm to stiff, brown silty Clay FILL	FILL	Boring advanced with 6-inch diameter hollow stem auger, Lower 5 ft 8-inch diameter
	C	13/18	P			← ATD
5				Stiff, brown, low to medium plastic Silty CLAY with organics	CL	Modified loess
	C	14/18	P			
	C	15/18	P			
10	C	16/18	P			
15				Becoming medium to low plastic		
	C	14/18	P			
20				Hard, brown, highly plastic CLAY with trace silt	CH	Residual
	C	16/18	P			
25				Becoming light gray		

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-41

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/16/81

OWC-3

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME-750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 527 ATD

SURFACE ELEVATION 529 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25				SAME: Hard, gray, highly plastic CLAY	CH	
30				Stiff, purple, highly plastic CLAY		
35						Bottom of Boring 35 ft Auger refusal 35'
40						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-42

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/16/81

OWC-4

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME-750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 509 ATD

SURFACE ELEVATION 519 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Firm to stiff, brown, silty Clay FILL	FILL	Boring advanced with 6-inch diameter hollow stem auger, Lower 5 ft 8-inch diameter
	C	12/18	P			
5	C	14/18	P	Stiff, brown, low to medium plastic Silty CLAY	CL	Modified loess
10	C	14/18	P	Becoming more silty		← ATD
15	C	14/18	P	Becoming medium plastic		
20	C	12/18	P	Hard, tan-brown, highly plastic CLAY with black iron deposits	CH	Residual
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-43

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/16/81

OWC-4

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME-750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 509 ATD

SURFACE ELEVATION 519 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25				SAME: Hard, highly plastic CLAY, becoming brown and purple	CH	
30						Bottom of Boring Auger refusal

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-44

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/5/81

OWC-5

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME-750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 500 ATD

SURFACE ELEVATION 515 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Stiff, brown, silty Clay FILL	FILL	Boring advanced with 6-inch diameter, Lower 5 ft 8-inch diameter
	C	10/18	P			
				Stiff, gray, low plastic Silty CLAY	CL	Stream deposit
5						
	C	15/18	P			
				Becoming hard		
	C	15/18	P			
				Stiff, brown and gray, medium plastic, Silty CLAY		Modified Loess
10						
	C	14/18	P			
	C	14/18	P			
						← ATD
15						
	C	14/18	P			
				Becoming light brown and gray, stiff, more silty		
	C	15/18	P			
20						
				Hard, yellow-tan, highly plastic CLAY	CH	
	C	15/18	P			
25				with purple shale fragments		Residual

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-45

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

OWC-5

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 2/5/81

RIG CME-750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 500 ATD

SURFACE ELEVATION 515 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	C	13/18	P	SAME: Hard, yellow-brown, highly plastic CLAY with large purple shale fragments	CH	
						Bottom of Boring 26.5 ft
30						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-46

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/2/81

OWC-6

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME-750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 514 ATD
El 516 24 hr AD

SURFACE ELEVATION 523 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0	C	11/18	P	Firm to stiff, brown, silty Clay FILL with gravel	FILL	Boring advanced with 6-inch diameter hollow stem auger, Lower 5-feet 8-inch diameter
	C	8/18	P	Without gravel		
5	C	14/18	P	Firm to stiff, brown, medium plastic, Silty CLAY with filled root holes and voids	CL	▽ 24 hrs AD Modified loess ← ATD
10	C	16/18	P			
15	C	14/18	P			
20	C	12/18	P	Stiff, brown, highly plastic CLAY with silt	CH	Residual
25				Becoming hard		

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-47

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/2/81

OWC-6

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME-750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 514 ATD
El 516 24 hr AD

SURFACE ELEVATION 523 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	C	12/18	P	SAME: Hard, varicolored, highly plastic CLAY with shale and fine sand	CH	
						Bottom of Boring 26.5 ft
30						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-48

BORING LOG

SHEET 1 OF 1

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/18/81

OWC-7

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME-750

LOGGED BY W. Prosser DRILLED BY G. Johanning

WATER ENTERS El 516 ATD

SURFACE ELEVATION 523 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				3 inches asphalt Loose, black, cinder and Gravel FILL	FILL	Boring advanced with 6-inch diameter hollow stem auger, Lower 5 ft 8-inch diameter
				Stiff, brown, low plastic silty Clay FILL		
5				Firm to stiff, gray, low plastic, Silty CLAY	CL	Strong odor ← ATD Stream deposit
				Stiff, brown, low plastic Silty CLAY	CL	Modified loess
10						
15				Becoming hard and medium to highly plastic	CL-CH	Residual
						Bottom of Boring 17 ft
20						
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-49

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/19/81

OWC-8

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME-750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 516 ATD

SURFACE ELEVATION 523 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Loose, black, cinder and Gravel FILL	F I L L	Boring advanced with 6-inch diameter hollow stem auger, Lower 5 ft 8-inch diameter
	C	13/18	P	Stiff, brown, silty Clay FILL		Strong odor
5	C	16/18	P	Firm to stiff, gray, Silty CLAY	CL	
	C	16/18	P			← ATD
						Stream deposit
				Firm to stiff, brown Silty CLAY		Modified loess
10	C	16/18	P	Becoming stiff		
15	C	16/18	P	Becoming tan to brown, medium plastic		
				Becoming hard		
20	C	16/18	P	Becoming medium to highly plastic	CL-CH	
				Stiff, tan to brown, highly plastic CLAY with trace silt	CH	Residual
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-50

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

OWC-8

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 2/19/81

LOGGED BY Peter Barrett DRILLED BY G. Johanning

RIG CME-750

SURFACE ELEVATION 523 ELEVATION DATUM USC & GS

WATER ENTERS El 516 ATD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	C	16/18	P	SAME: Stiff, tan-brown, highly plastic CLAY with trace silt	CH	
						Bottom of Boring 27.5 ft
30						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-51

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

OWC-9

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 1/28/81

LOGGED BY Peter Barrett DRILLED BY G. Johanning

RIG CME-750

SURFACE ELEVATION 532 ELEVATION DATUM USC & GS

WATER ENTERS El 529 ATD
El 531 24 hrs AD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Stiff, gray silty Clay FILL with organics	FILL	▼ 24 hrs AD
	C	9/18	P			Boring advanced with 6-inch diameter hollow stem auger,
	C	10/18	P	Stiff, gray, low plastic Silty CLAY with organics	CL	Lower 5 ft, 8-inch water detected ATD
5						Stream deposit
	C	11/18	P	Stiff, brown, low to medium plastic Silty CLAY		Modified loess
10	C	16/18	P			
				Very stiff, red-brown, highly plastic CLAY	CH	Residual
15	C	12/18	P			
20	C	11/18	P	Becoming brown, with black ferrous deposits		
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-52

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON
ST. LOUIS, MISSOURI

PROJECT NO. S81-5

DATE 1/28/81

OWC-9

PROJECT LOCATION

RIG CME-750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 529 ATD
El 531 24 hrs AD

SURFACE ELEVATION 532 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	C	11/18	P	SAME: Very stiff, brown, highly plastic CLAY with black ferrous deposits	CH	
				Hard, gray-brown, CLAY with fine sand and shale fragments	CH-SH	
30	C	8/12	P			
35	C	6/18	P	Becoming orange-brown, without fine sand; very shaley		
40						Auger refusal
45				LIMESTONE	LS	Bottom of Boring 44.0 ft
50						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-53

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 1/28/81

OWC-10

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME-750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 523 ATD
El 523 24 Hr AD

SURFACE ELEVATION 528 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Loose, gravel and asphalt FILL	F	Boring advanced with
				Stiff, brown, highly plastic clay FILL	I	6-inch diameter
	C	10/18	P	Stiff, brown, highly plastic Clay FILL	L	hollow stem auger,
					L	Lower 5 ft 8-inch
						with odor
	C			Gravel and asphalt		
	C	5/18	P	Stiff, brown-gray, plastic Clay FILL with brick and organics		← ATD
5						▼ 24 hr AD
	C	10/18	P	Stiff, gray, low plastic Silty CLAY	CL	Stream deposit
	C	11/18	P			Organically stained
10						
	C	11/18	P	Stiff, brown, low to medium plastic Silty CLAY		Modified loess (without odor)
15	C	16/18	P			
				Becoming predominantly gray		
20	C	14/18	P			
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-54

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 1/28/81

OWC-10

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME-750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 523 ATD
El 523 24 hrs AD

SURFACE ELEVATION 528 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	C	16/18	P	SAME: Stiff, gray with brown, medium plastic Silty CLAY	CL	
				Stiff, brown and purple, medium plastic Silty CLAY with shale fragments and fine sand	CL-CH	Residual
30	C	6/8	P			
				Firm, multi-colored, highly plastic CLAY with limestone and shale fragments and trace silt	CH	
35	C	14/18	6 7 3			
				LIMESTONE	LS	Bottom of Boring 36.8 ft
40						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-55

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 1/27/81

OWC-11

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME-750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS 503.5 ATD

SURFACE ELEVATION 524 ELEVATION DATUM USC & GS

El 514 24 hrs AD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Asphalt		
				Stiff, brown, silty Clay FILL	F	with odor
	C	6/18	P		I	Boring advanced with
					L	6-inch diameter
					L	hollow stem auger,
				Becoming firm to stiff, with organic zones		Lower 5 ft, 8-inch
	C	5/18	P			
5						
	C	4/6	P			
				Rubble, asphalt		
	C	14/18	P	Stiff, gray, Silty CLAY	CL	Stream deposit
	C	13/18	P	Stiff, brown, Silty CLAY with organics		Modified Loess
						Less odor (only
						just detectable)
10						▼ 24 hrs AD
	C	13/18	P			
15						
	C	14/18	P			
20						
	C	13/18	P			← ATD
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-56

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

OWC-11

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 1/27/81

RIG CME-750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS 503.5 ATD

SURFACE ELEVATION 524 ELEVATION DATUM USC & GS

El 514 24 hrs AD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25	C	12/14	P	SAME: Stiff, brown, low-medium plastic, Silty CLAY Becoming more plastic	CL	
				Stiff, brown, highly plastic CLAY with rock fragments and trace silt	CH	Residual
30	C	10/14	P	Becoming gray and brown, very highly plastic, weathered sandstone stringer		
35						Auger refusal
	S	0/1	30/1"	LIMESTONE	LS	Bottom of Boring 35.0 ft

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-57

BORING LOG

SHEET 1 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

OWC-12

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 2/20/81

RIG CME-750

LOGGED BY W. Prosser DRILLED BY G. Johanning

WATER ENTERS El 503.5 ATD
El 514 24 hrs AD

SURFACE ELEVATION 524 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				3 inch asphalt Firm to stiff, brown and gray, silty Clay FILL, with asphalt and concrete fragments	FILL	Boring advanced with 6-inch diameter hollow stem auger, Lower 5 ft 8-inch With odor
5				Stiff, gray, Silty CLAY	CL	Stream deposit
				Stiff, brown, Silty CLAY with organics		Some odor
10						▽ 24 hr AD Modified loess
				Becoming firm to stiff, and low to medium plastic		
15						
20						← ATD
				Stiff to hard, multicolored, highly plastic CLAY with some silt and rock fragments	CH	
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-58

BORING LOG

SHEET 2 OF 2

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/20/81

OWC-12

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME-750

LOGGED BY W. Prosser DRILLED BY G. Johanning

WATER ENTERS El 503.5 ATD
El 514 24 hr AD

SURFACE ELEVATION 524 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25				SAME: Stiff, multicolored, highly plastic CLAY	CH	
30						Boring continued with NX core barrel, diamond bit and water
				LIMESTONE: Light gray, slightly weathered with horizontal and vertical clay seams	LS	
35	NX CORE RUN #1	60/60 100%				Run #1 Start: 32.3' Stop: 37.3 Rec: 100% DWR: 80%
40	CORE RUN #2	36/36 100%				Run #2 Start: 37.3' Stop: 40.3' Rec: 100% DWR: 100%
						Bottom of Boring 40.3 ft
45						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-59

BORING LOG

SHEET 1 OF 1

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/5/81

OWC-13

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME-750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 510 ATD

SURFACE ELEVATION 516 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Firm to stiff, brown and gray silty Clay FILL	F I L L	Boring advanced with 6-inch diameter hollow stem auger, Lower 5 ft, 8-inch
	C	8/18	P			With odor
	C	16/18	P	Firm to stiff, gray, low plastic CLAY with organics	CL	Clay stained bright purple Stream deposit
5						ATD
	C	8/18	P	Firm to stiff, brown to gray, low plastic, Silty CLAY with organics and iron stain		
	C	12/18	P			Modified loess
10						
	C	8/18	P			
15						
	C	18/18	P	Becoming more plastic		Some odor
20						
	C	15/18	P	Stiff, tan, highly plastic CLAY with shale structure	CH	Residual
						Bottom of Boring 21.5 ft
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-60

BORING LOG

SHEET 1 OF 1

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

OWC-14

PROJECT LOCATION ST. LOUIS, MISSOURI

DATE 2/6/81

LOGGED BY Peter Barrett DRILLED BY G. Johanning

RIG CME-750

SURFACE ELEVATION 512 ELEVATION DATUM USC & GS

WATER ENTERS None Detected ATD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0	C	10/18	P	Firm to stiff, brown, Clay FILL	FILL	Boring advanced with 6-inch diameter hollow stem auger, Lower 5 ft 8-inch
	C	13/18	P	Stiff, brown, becoming gray at base, low plastic Silty CLAY with iron deposits	CL	Some odor Stream deposit
5	C	12/18	P			
	C	13/18	P	Stiff, brown to tan, medium plastic Silty CLAY		Modified loess
10	C	15/18	P	Becoming more silty		
15	C	13/18	P			
20	C	12/18	P	Hard, tan-brown, highly plastic CLAY with shale fragments	CH	Residual
	C	12/18	P			
25						Bottom of Boring 23.5 ft

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-61

BORING LOG

SHEET 1 OF 1

PROJECT NAME ORTHO CHEVRON

PROJECT NO. S81-5

DATE 2/6/81

OWC-15

PROJECT LOCATION ST. LOUIS, MISSOURI

RIG CME-750

LOGGED BY Peter Barrett DRILLED BY G. Johanning

WATER ENTERS El 500 ATD

SURFACE ELEVATION 514 ELEVATION DATUM USC & GS

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Firm to stiff, brown, Silty CLAY	CL	Boring advanced with 6-inch diameter hollow stem auger; Lower 5 ft, 8-inch Modified Loess
	C	10/18	P			
5	C	13/18	P			
10	C	13/18	P	Becoming medium plastic		
						ATD
15	C	17/18	P	Stiff, brown, highly plastic CLAY	CH	
				Hard, tan and gray, highly plastic CLAY with shale fragments		Residual
20	C	9/18	P			
						Bottom of Boring 21.5 ft
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. A-62

APPENDIX B

WELL PROFILES

PIEZOMETER INSTALLATION REPORT

Project ORTHO-CHEVRON
Project No. S81-5 Installed By W.C.C.
Piezometer No. OWC - 1
Location ST. LOUIS, MISSOURI
Date 2-18-81 Time

Method of Installation Well screen and riser pipe were installed immediately after the augers were removed from the boring. Drilling fluid was not required.

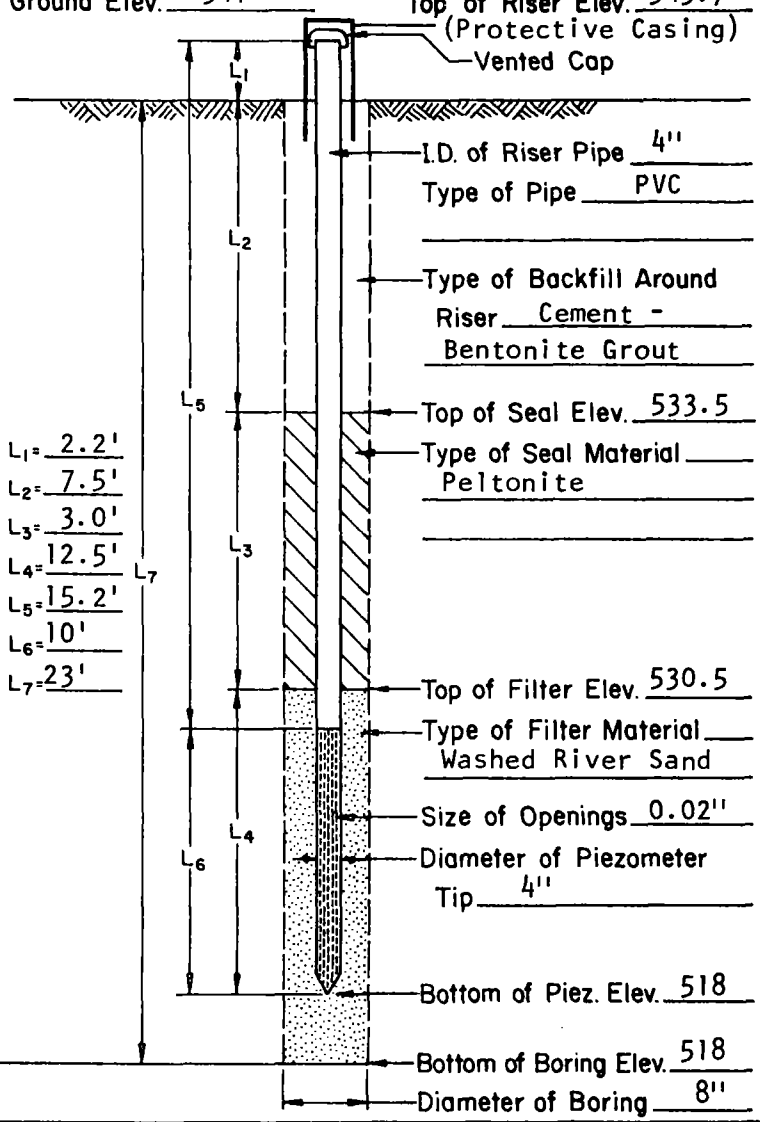
LOG OF BORING AND PIEZOMETER

BORING

Depth in ft.	Description	Symbol
0	Firm to stiff, brown, low plastic, Silty CLAY	CL
5		
10		
15	Becoming medium plastic	
	Hard, tan-brown, highly plastic CLAY with trace of silt	CH
20	Becoming multi-colored, with shaley sections	
25		

PIEZOMETER

Type of Piezometer PVC Observation Well



Remarks Bottom of boring: 23'

Inspected By Peter Barrett

WOODWARD – CLYDE CONSULTANTS

PIEZOMETER INSTALLATION REPORT

Project ORTHO-CHEVRON
Project No. S81-5 Installed By W.C.C.
Piezometer No. OWC - 2
Location ST. LOUIS, MISSOURI
Date 2-17&18-81 Time

Method of Installation NX-size double tube core barrel used to core limestone. Clean water added to cool core barrel. Water was not recirculated. Screen is 10 ft of hacksaw-slotted PVC pipe. Screen and riser pipe were installed after core barrel was removed.

LOG OF BORING AND PIEZOMETER

BORING

Depth in ft.	Description	Symbol
0	Firm to stiff, brown, low to medium plastic, Silty CLAY	CL
20	Hard, tan-brown, highly plastic CLAY with trace of silt	CH
	Becoming multi-colored, shaley	CH | SH
	Becoming gray with fine sand	SH
40	LIMESTONE	LS
	SHALE: Calcareous, gray	SH
	Becoming purple	
60	LIMESTONE: Massive, light gray, unweathered with 4' of quartz at the top (with pyrite cube)	LS
80		

PIEZOMETER

Type of Piezometer PVC Observation Well

Ground Elev. 541
Top of Riser Elev. 542.3
(Protective Casing)
Vented Cap

L_1 = 0.8'
L_2 = 55'
L_3 = 2.5'
L_4 = 12'
L_5 = 60.3'
L_6 = 10'
L_7 = 69.5'

I.D. of Riser Pipe 1.5"
Type of Pipe PVC
Type of Backfill Around Riser Cement - Bentonite Grout
Top of Seal Elev. 486.0
Type of Seal Material Peltonite
Top of Filter Elev. 483.5
Type of Filter Material Washed River Sand
Size of Openings 0.02"
Diameter of Piezometer Tip 1.5"
Bottom of Piez. Elev. 471.5
Bottom of Boring Elev. 471.5
Diameter of Boring 6"; 3"

Remarks Bottom of boring: 69.5'

Inspected By Peter Barrett

WOODWARD – CLYDE CONSULTANTS

PIEZOMETER INSTALLATION REPORT

Project ORTHO-CHEVRON
Project No. S81-5 Installed By W.C.C.
Piezometer No. OWC - 3
Location ST. LOUIS, MISSOURI
Date 2-16-81 Time

Method of Installation Well screen and riser pipe were installed immediately after augers were removed from the boring. Drilling fluid was not required.

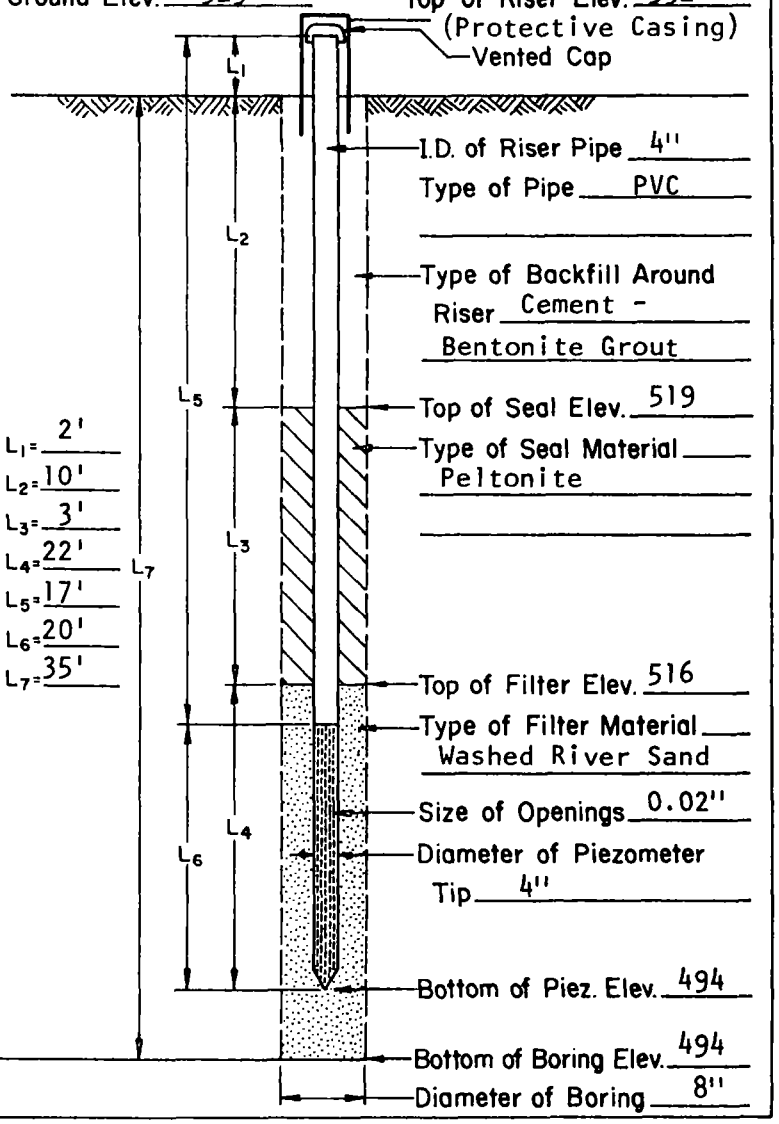
LOG OF BORING AND PIEZOMETER

BORING

Depth in ft.	Description	Symbol
0	Firm to stiff, brown, Silty Clay FILL	FILL
	Stiff, brown, low to medium plastic, Silty CLAY	CL
10		
20	Hard, brown, highly plastic CLAY Becoming light gray	CH
30	Stiff, purple, highly plastic CLAY	CH
	LIMESTONE:	LS
40		

PIEZOMETER

Type of Piezometer PVC Observation Well



Remarks Bottom of boring: 35'

Inspected By Peter Barrett

WOODWARD – CLYDE CONSULTANTS

PIEZOMETER INSTALLATION REPORT

Project ORTHO-CHEVRON
Project No. S81-5 Installed By W.C.C.
Piezometer No. OWC - 4
Location ST. LOUIS, MISSOURI
Date 2-17-81 Time

Method of Installation Well screen and riser pipe were installed immediately after augers were removed from the boring. Drilling fluid was not required.

LOG OF BORING AND PIEZOMETER

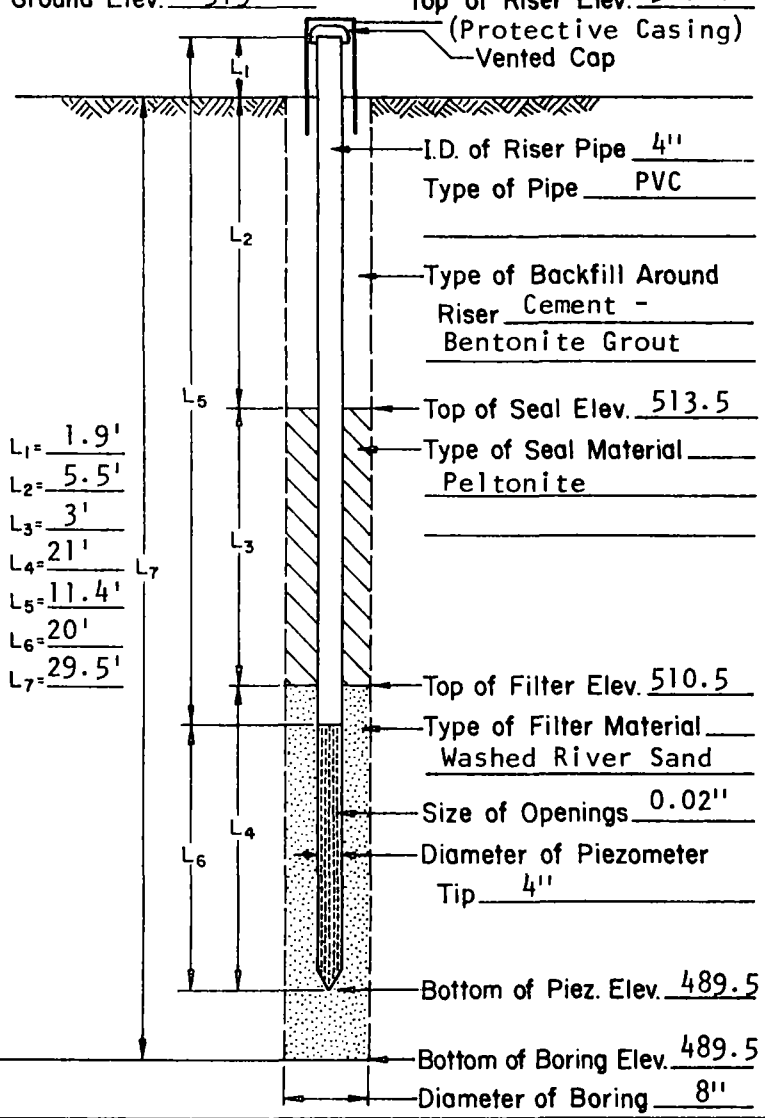
BORING

Depth in ft.	Description	Symbol
0	Firm to stiff, brown, low plastic Clay FILL	FILL
	Stiff, brown, low to medium plastic, Silty CLAY	CL
10	Becoming more plastic	CL / CH
20	Hard, tan to brown, highly plastic CLAY with black iron stains	CH
	Becoming brown and purple	
30		

PIEZOMETER

Type of Piezometer PVC Observation Well

Ground Elev. 519



Remarks Bottom of boring: 29.5' (Auger Refusal)

Inspected By Peter Barrett

WOODWARD – CLYDE CONSULTANTS

PIEZOMETER INSTALLATION REPORT

Project ORTHO-CHEVRON
Project No. S81-5 Installed By W.C.C.
Piezometer No. OWC - 5
Location ST. LOUIS, MISSOURI
Date 2-5-81 Time

Method of Installation Well screen and riser pipe were installed immediately after augers were removed from boring. Drilling fluid was not required.

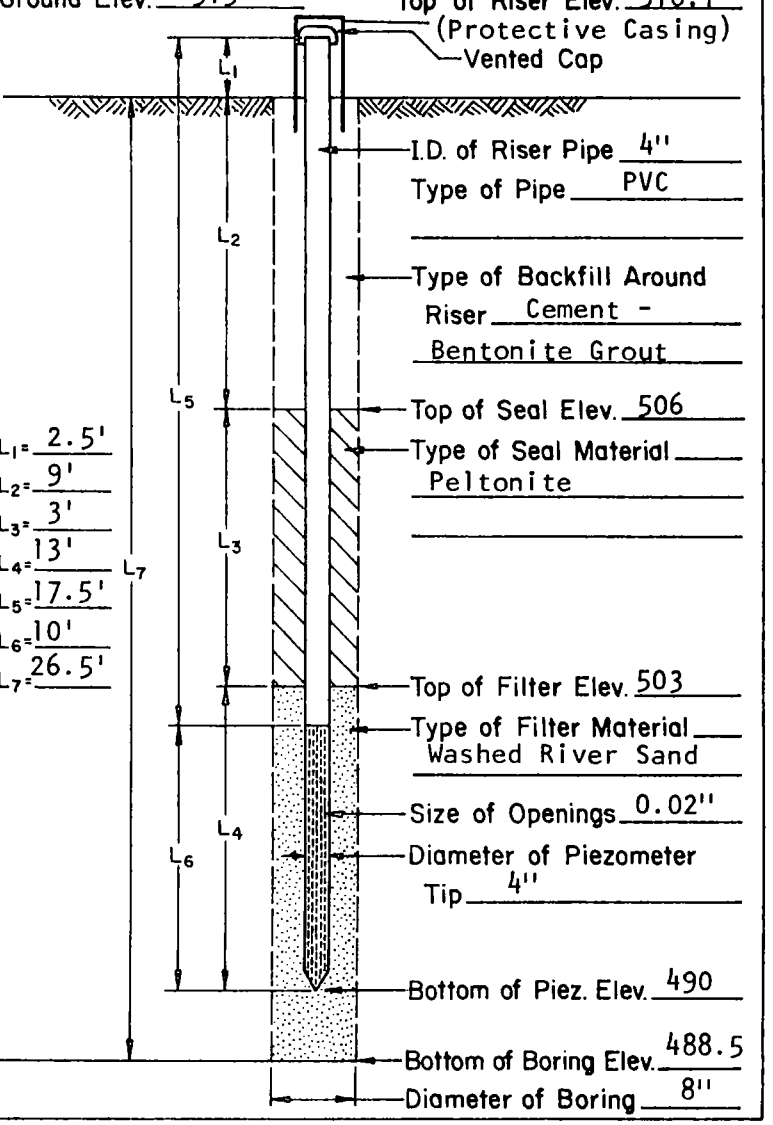
LOG OF BORING AND PIEZOMETER

BORING

Depth in ft.	Description	Symbol
0	Stiff, brown, Clay FILL	FILL
	Stiff, gray, low plastic, Silty CLAY	CL
	Becoming hard	
10	Becoming brown and gray, medium plastic	
	Becoming light brown and gray, stiff, more silty	CL
20	Medium-highly plastic with purple shale fragments	I
	Hard, yellow-brown, highly plastic	CH
		CH
30		

PIEZOMETER

Type of Piezometer PVC Observation Well



Remarks Bottom of boring: 26.2' (Auger Refusal)

Inspected By P. J. Knotts

WOODWARD – CLYDE CONSULTANTS

PIEZOMETER INSTALLATION REPORT

Project ORTHO-CHEVRON
Project No. S81-5 Installed By W.C.C.
Piezometer No. OWC - 6
Location ST. LOUIS, MISSOURI
Date 2-2-81 Time

Method of Installation This boring caved prior to setting well screen. Clean water was pumped through drill stem to flush the boring. The water was not recirculated. Well screen and riser pipe were installed immediately after the boring was flushed.

LOG OF BORING AND PIEZOMETER

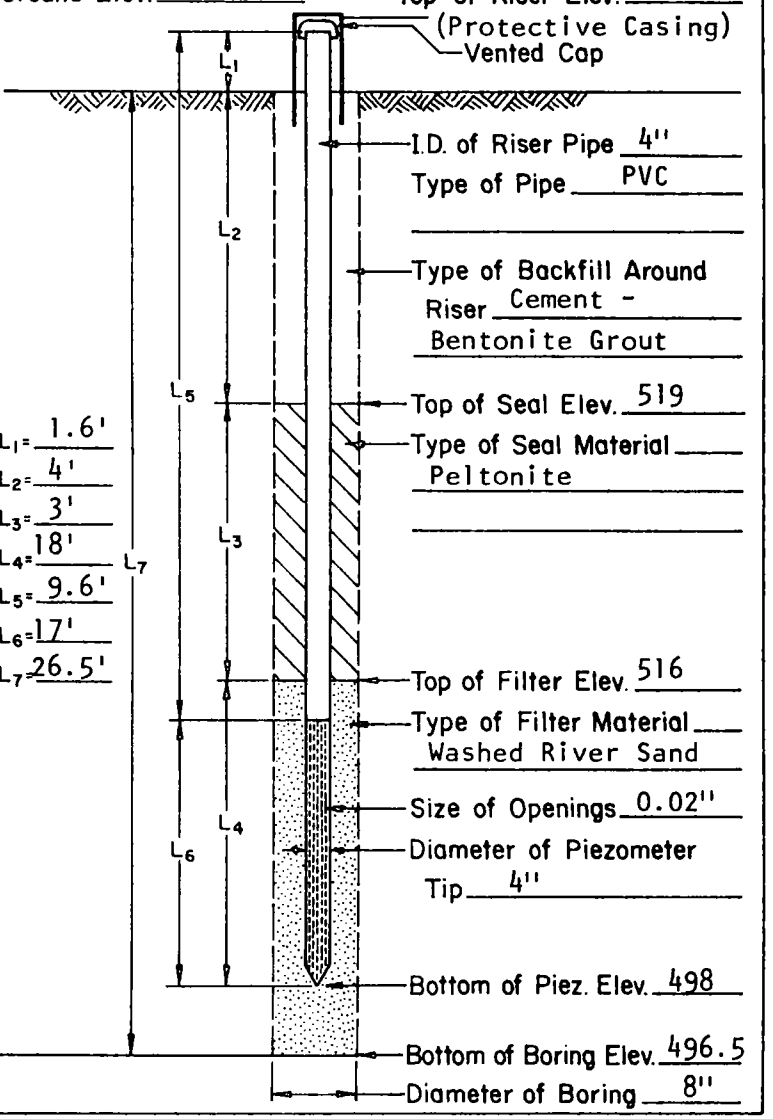
BORING

Depth in ft.	Description	Symbol
0	Firm to stiff, brown CLAY Fill with gravel	FILL
	Firm to stiff, brown, low to medium plastic, Silty CLAY with rootholes and voids	CL
10	Becoming medium plastic	
20	Stiff, brown, highly plastic CLAY with silt	CH
	Hard, vari-colored with shale and fine sand	
30		

PIEZOMETER

Type of Piezometer PVC Observation Well

Ground Elev. 523



L_1 = 1.6'
L_2 = 4'
L_3 = 3'
L_4 = 18'
L_5 = 9.6'
L_6 = 17'
L_7 = 26.5'

Remarks Bottom of boring: 26.2'

Inspected By P. J. Knotts

WOODWARD – CLYDE CONSULTANTS

PIEZOMETER INSTALLATION REPORT

Project ORTHO-CHEVRON
Project No. S81-5 Installed By W.C.C.
Piezometer No. OWC - 7
Location ST. LOUIS, MISSOURI
Date 2-18-81 Time

Method of Installation Well screen and riser pipe were installed immediately after the augers were removed from the boring. Drilling fluid was not required.

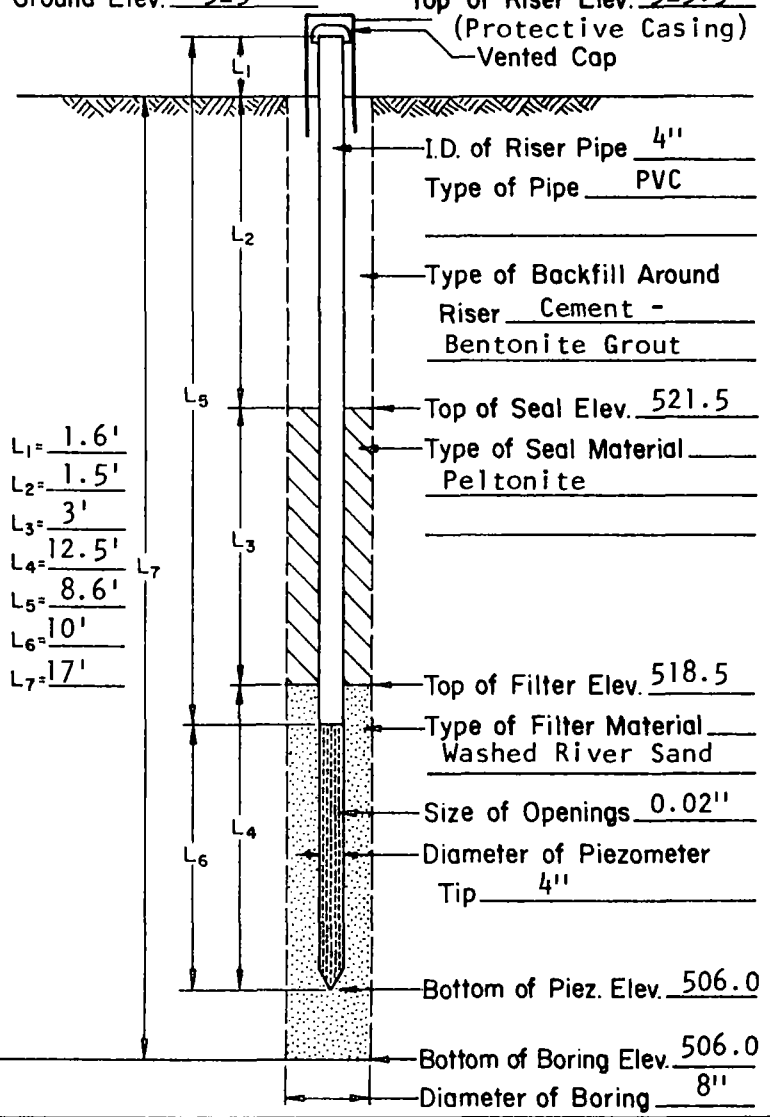
LOG OF BORING AND PIEZOMETER

BORING

Depth in ft.	Description	Symbol
0	Black cinder and gravel FILL with clay	FILL
	Stiff, brown, low plastic, Silty CLAY	CL
5		
	Firm to stiff, gray, low plastic, Silty CLAY	CL
	Firm to stiff, brown, low plastic, Silty CLAY	CL
10	Becoming stiff	
15	Becoming tan-brown, medium plastic	CL
	Becoming hard, medium-highly plastic	I CH
20		

PIEZOMETER

Type of Piezometer PVC Observation Well



Remarks Bottom of boring: 17.0'

Inspected By Peter Barrett

WOODWARD – CLYDE CONSULTANTS

PIEZOMETER INSTALLATION REPORT

Project ORTHO-CHEVRON
Project No. S81-5 Installed By W.C.C.
Piezometer No. OWC - 8
Location ST. LOUIS, MISSOURI
Date 2-19-81 Time

Method of Installation This boring caved prior to setting well screen. The boring was flushed by pumping clean water through the drill stem. The water was not recirculated. Well screen and riser pipe were installed immediately after flushing the boring.

LOG OF BORING AND PIEZOMETER

BORING

Depth in ft.	Description	Symbol
0	Black cinder and gravel FILL with clay	FILL
	Stiff, brown, low plastic, Silt Silty CLAY	CL
	Firm-stiff, gray, low plastic, Silty CLAY	CL
10	Firm-stiff, brown, low plastic, Silty CLAY Becoming stiff	
	Becoming tan-brown, medium plastic	CL
		I
20	Becoming hard, medium-highly plastic	CH
	Stiff-hard, tan-brown, highly plastic CLAY with trace of silt	CH
30		

PIEZOMETER

Type of Piezometer PVC Observation Well

Ground Elev. 523
Top of Riser Elev. 525.7
(Protective Casing)
Vented Cap

L_1 = 2.1'
L_2 = 13.5'
L_3 = 3'
L_4 = 11'
L_5 = 20.6'
L_6 = 9'
L_7 = 27.5'

I.D. of Riser Pipe 4"
Type of Pipe PVC
Type of Backfill Around Riser Cement - Bentonite Grout
Top of Seal Elev. 509.5
Type of Seal Material Peltonite
Top of Filter Elev. 506.5
Type of Filter Material Washed River Sand
Size of Openings 0.02"
Diameter of Piezometer Tip 4"
Bottom of Piez. Elev. 495.5
Bottom of Boring Elev. 495.5
Diameter of Boring 8"

Remarks Bottom of boring: 27.5'

Inspected By Peter Barrett

WOODWARD – CLYDE CONSULTANTS

PIEZOMETER INSTALLATION REPORT

Project ORTHO-CHEVRON
Piezometer No. OWC - 9
Location ST. LOUIS, MISSOURI
Project No. S81-5
Installed By W.C.C.
Date 2-10-81
Time

Method of Installation Well screen and riser pipe were installed immediately after augers were removed from the boring. Drilling fluid was not required.

LOG OF BORING AND PIEZOMETER

BORING

Depth in ft.	Description	Symbol
0	Stiff, gray, Silty Clay FILL with cinders and organics	FILL
	Stiff, gray, Silty CLAY with organics	CL
	Stiff, brown, low plastic, Silty CLAY	CL
10		
	Very stiff, red-brown, highly plastic CLAY	CH
20	Becoming brown with black iron deposits	
	Hard, gray-brown, CLAY with fine sand and shale fragments	CH | SH
30	Becoming orange-brown, very shaley	
40		
	LIMESTONE	LS
50		

PIEZOMETER

Type of Piezometer PVC Observation Well

Ground Elev. 532
Top of Riser Elev. 534.8
(Protective Casing)
Vented Cap

L_1 = 2.2'
L_2 = 6.5'
L_3 = 3'
L_4 = 22.5'
L_5 = 14.2'
L_6 = 20'
L_7 = 32'

I.D. of Riser Pipe 4"
Type of Pipe PVC
Type of Backfill Around Riser Cement - Bentonite Grout
Top of Seal Elev. 525.5
Type of Seal Material Peltonite
Top of Filter Elev. 522.5
Type of Filter Material Washed River Sand
Size of Openings 0.02"
Diameter of Piezometer Tip 4"
Bottom of Piez. Elev. 500
Bottom of Boring Elev. 500
Diameter of Boring 8"

Remarks Bottom of boring: 44.0'

Inspected By P. J. Knotts

WOODWARD – CLYDE CONSULTANTS

PIEZOMETER INSTALLATION REPORT

Project ORTHO-CHEVRON
Project No. S81-5 Installed By W.C.C.
Piezometer No. OWC - 10
Location ST. LOUIS, MISSOURI
Date 2-13-81 Time

Method of Installation Well screen and riser pipe were installed immediately after the augers were removed from the boring. Drilling fluid was not required.

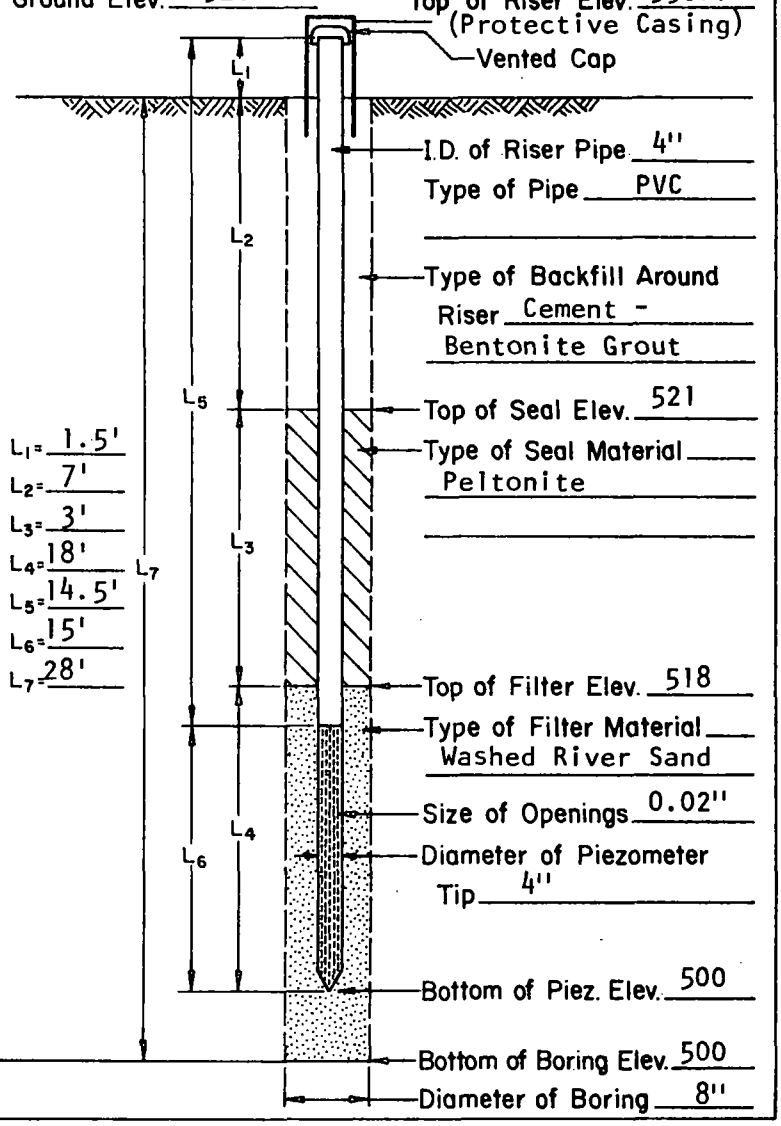
LOG OF BORING AND PIEZOMETER

BORING

Depth in ft.	Description	Symbol
0	Stiff, brown-gray, highly plastic Clay FILL with organics and bricks	FILL
	Stiff, gray, low plastic, Silty CLAY	CL
10	Stiff, brown, low to medium plastic, Silty CLAY	CL
	Becoming gray	
20		
	Stiff to firm, brown and purple, medium to low plastic, Silty CLAY with shale	
30		
	Firm-soft, multi-colored, highly plastic CLAY with limestone and shale fragments	CH
	LIMESTONE	LS
40		

PIEZOMETER

Type of Piezometer PVC Observation Wells



Remarks Bottom of boring: 28.0'

Inspected By P. J. Knotts

WOODWARD – CLYDE CONSULTANTS

PIEZOMETER INSTALLATION REPORT

Project ORTHO-CHEVRON
Project No. S81-5 Installed By W.C.C.
Piezometer No. OWC - 11
Location ST. LOUIS, MISSOURI
Date 2-19-81 Time

Method of Installation Well screen and riser pipe were installed immediately after augers were removed from the boring. Drilling fluid was not required.

LOG OF BORING AND PIEZOMETER

BORING

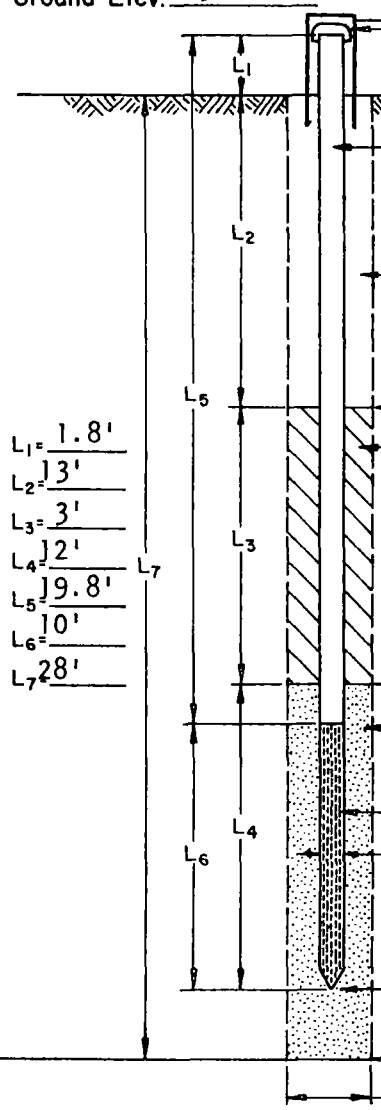
Depth in ft.	Description	Symbol
0	Stiff, brown, Silty Clay FILL	FILL
	With rubble	
	Stiff, gray, low plastic, Silty CLAY	CL
10	Stiff, brown, low plastic, Silty CLAY	CL
20		
	Stiff to hard, brown, highly plastic CLAY	CH
30		

PIEZOMETER

Type of Piezometer PVC Observation Well

Ground Elev. 524
Top of Riser Elev. 526.2
(Protective Casing)
Vented Cap

L_1 = 1.8'
L_2 = 13'
L_3 = 3'
L_4 = 12'
L_5 = 19.8'
L_6 = 10'
L_7 = 28'



I.D. of Riser Pipe 4"
Type of Pipe PVC
Type of Backfill Around Riser Cement - Bentonite Grout
Top of Seal Elev. 511.0
Type of Seal Material Peltonite
Top of Filter Elev. 508.0
Type of Filter Material Washed River Sand
Size of Openings 0.02"
Diameter of Piezometer Tip 4"
Bottom of Piez. Elev. 496
Bottom of Boring Elev. 496
Diameter of Boring 8"

Remarks Bottom of boring: 28.0'

Inspected By Peter Barrett

WOODWARD – CLYDE CONSULTANTS

PIEZOMETER INSTALLATION REPORT

Project ORTHO-CHEVRON
Piezometer No. OWC - 12
Location ST. LOUIS, MISSOURI
Project No. S81-5 Installed By W.C.C.
Date 2-20-81 Time

Method of Installation NX-size double tube core barrel was used to core the limestone. Clean water was used to cool the core barrel. The water was not recirculated. Well screen and riser pipe were installed immediately after core barrel was removed from the boring.

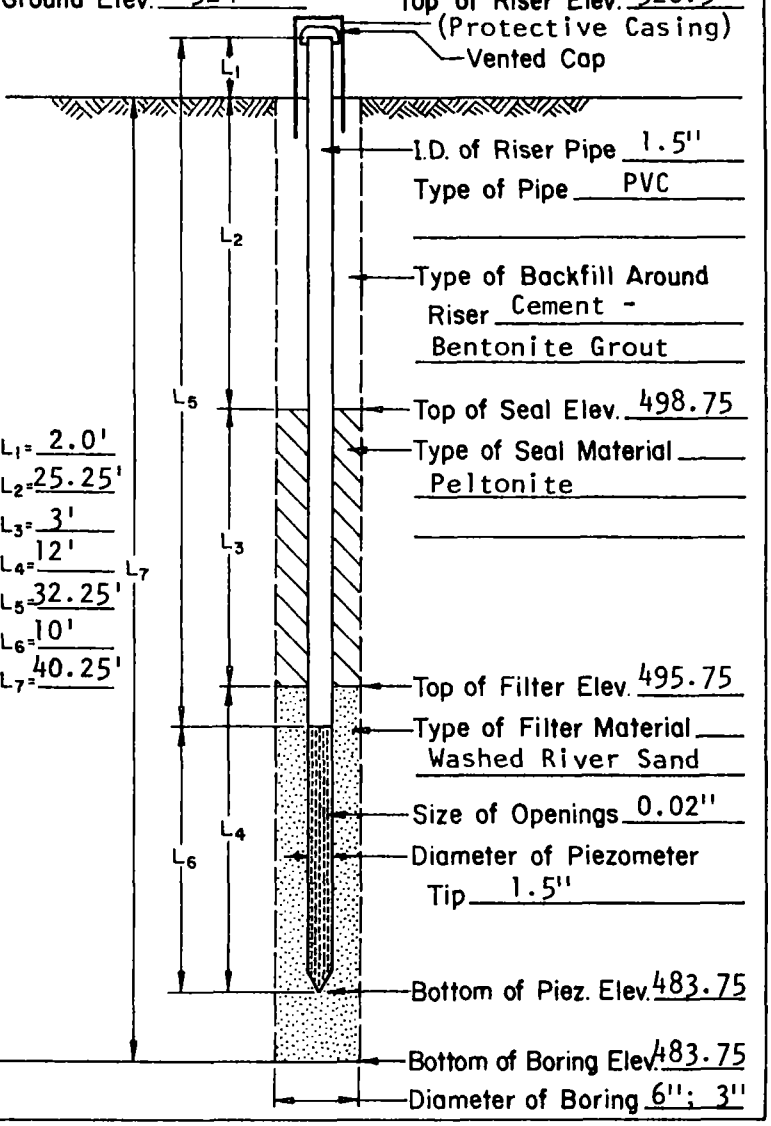
LOG OF BORING AND PIEZOMETER

BORING

Depth in ft.	Description	Symbol
0	Firm to stiff, brown and gray, Silty Clay FILL	FILL
10	Stiff, brown, low plastic, Silty CLAY Becoming low to medium plastic	CL
20	Becoming medium plastic	
30	Stiff to hard, multi-colored, highly plastic CLAY with trace of silt and rock fragments	CH
40	LIMESTONE: Gray, weathered with horizontal and vertical clay seams	LS
50		

PIEZOMETER

Type of Piezometer PVC Observation Well



Remarks Bottom of boring: 40.3'

Inspected By Peter Barrett

WOODWARD – CLYDE CONSULTANTS

PIEZOMETER INSTALLATION REPORT

Project ORTHO-CHEVRON
Project No. S81-5 Installed By W.C.C.
Piezometer No. OWC - 13
Location ST. LOUIS, MISSOURI
Date 2-5-81 Time

Method of Installation Well screen and riser pipe were installed immediately after the augers were removed from the boring. Drilling fluid was not required.

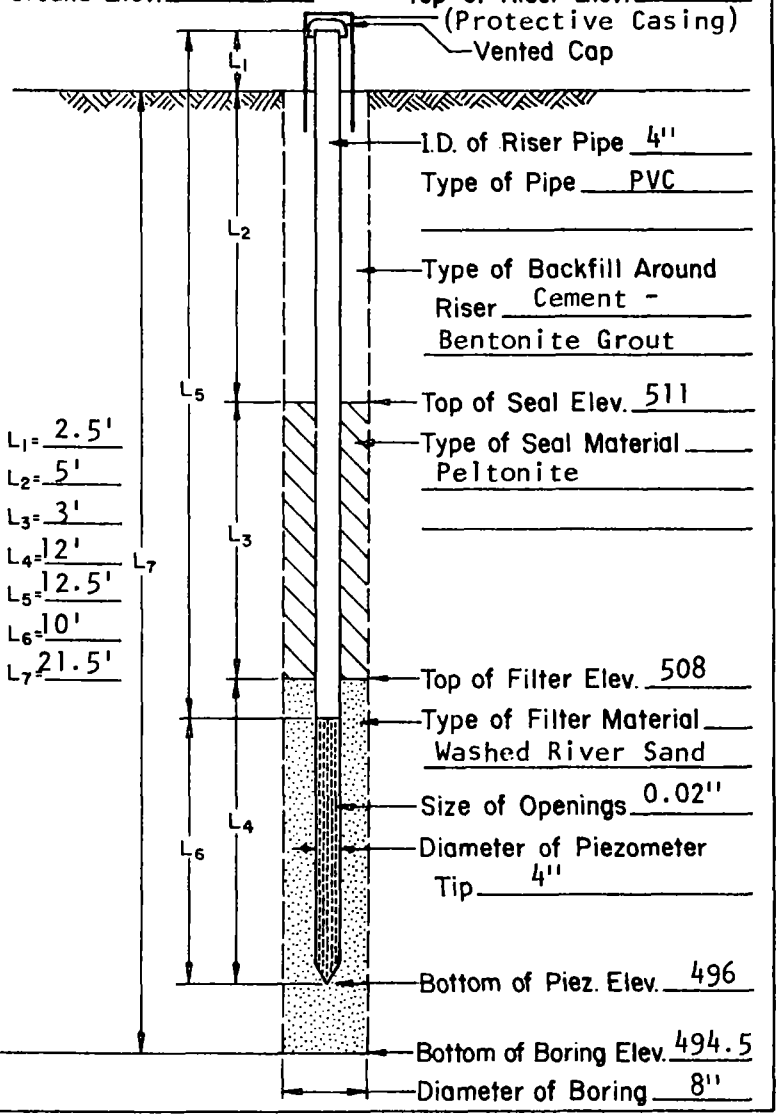
LOG OF BORING AND PIEZOMETER

BORING

Depth in ft.	Description	Symbol
0	Firm to stiff, brown and gray, low plastic Clay FILL	FILL
5	Firm to stiff, gray, low plastic CLAY with organics	CL
10	Firm to stiff, brown, low plastic, Silty CLAY with organics	CL
15	Becoming more plastic	
20	Stiff to hard, tan, highly plastic, Shaley CLAY	CH
25		

PIEZOMETER

Type of Piezometer PVC Observation Well



Remarks Bottom of boring: 21.5'

Inspected By P. J. Knotts

WOODWARD – CLYDE CONSULTANTS

PIEZOMETER INSTALLATION REPORT

Project ORTHO-CHEVRON
Project No. S81-5 Installed By W.C.C.
Piezometer No. OWC - 14
Location ST. LOUIS, MISSOURI
Date 2-6-81 Time

Method of Installation Well screen and riser pipe were installed immediately after augers were removed from the boring. Drilling fluid was not required.

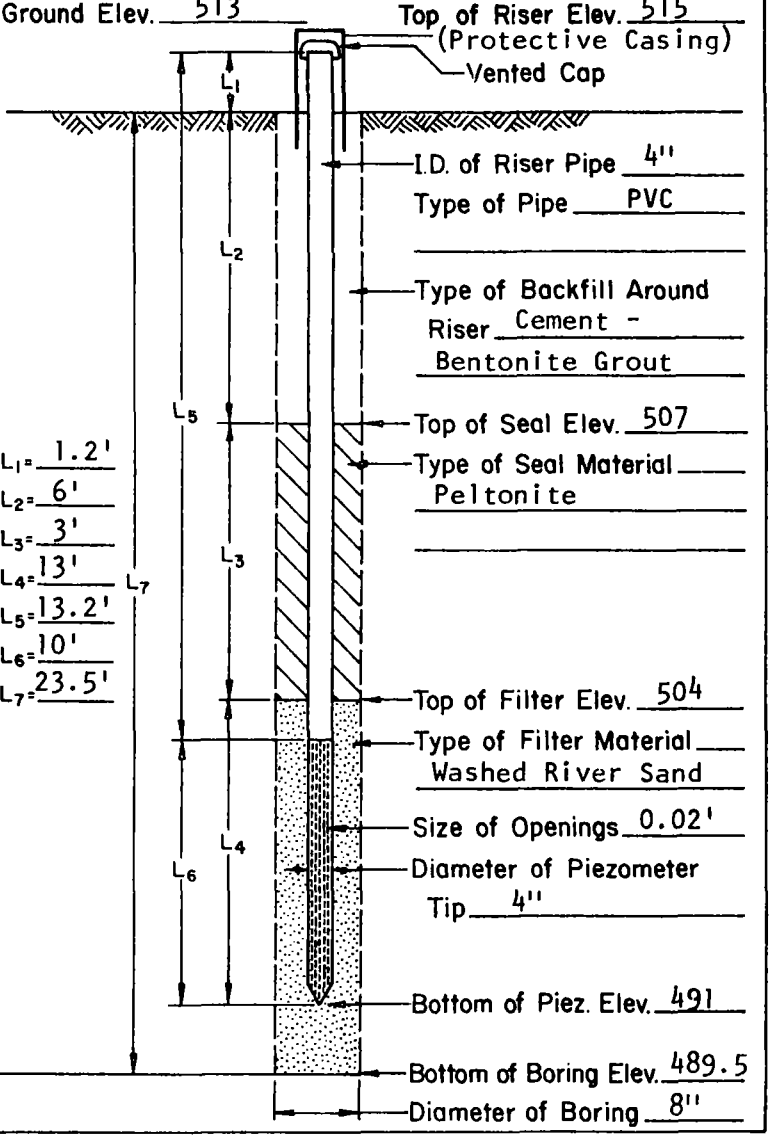
LOG OF BORING AND PIEZOMETER

BORING

Depth in ft.	Description	Symbol
0	Firm to stiff, brown clay FILL	FILL
	Stiff, brown-gray, low plastic, Silty CLAY	CL
5		
	Stiff to hard, brown-tan, low to medium plastic, Silty CLAY	
10		
15		
	Hard, tan-brown, highly plastic CLAY with shale fragments	CH
20		
25		

PIEZOMETER

Type of Piezometer PVC Observation Well



Remarks Bottom of boring: 23.5'

Inspected By P. J. Knotts

WOODWARD – CLYDE CONSULTANTS

PIEZOMETER INSTALLATION REPORT

Project ORTHO-CHEVRON
Project No. S81-5 Installed By W.C.C.
Piezometer No. OWC - 15
Location ST. LOUIS, MISSOURI
Date 2-6-81 Time

Method of Installation Well screen and riser pipe were installed immediately after augers were removed from the boring. Drilling fluid was not required.

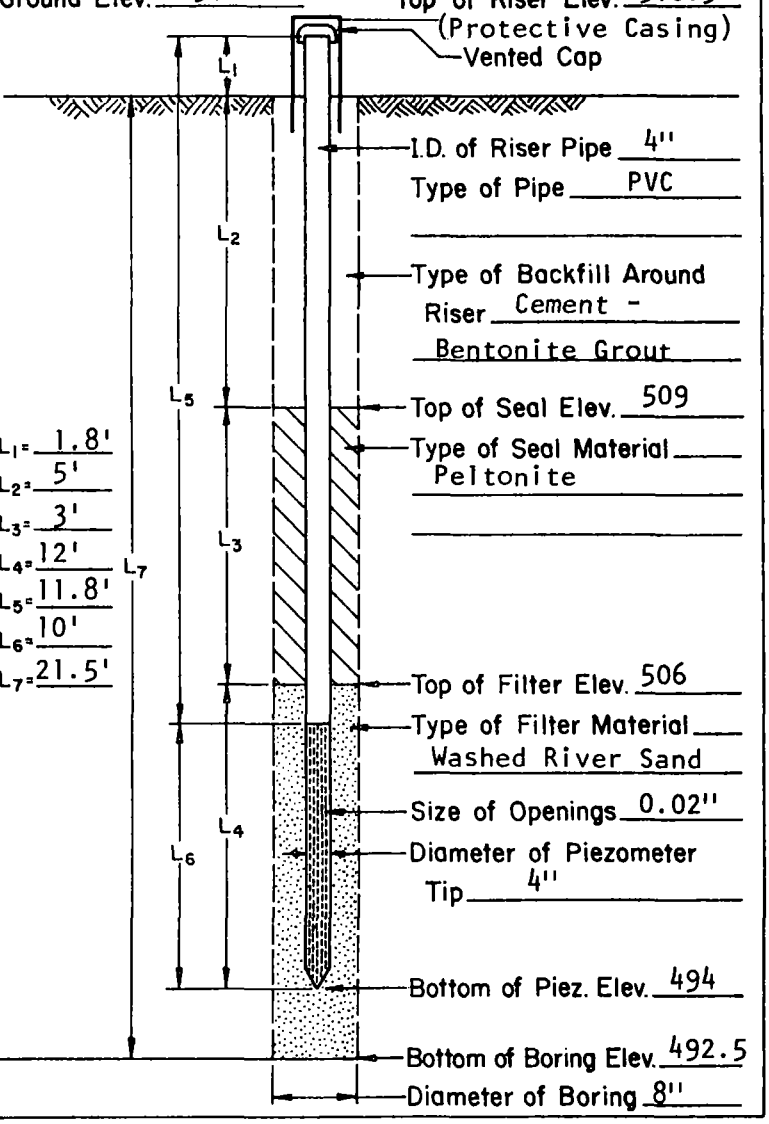
LOG OF BORING AND PIEZOMETER

BORING

Depth in ft.	Description	Symbol
0	Firm to stiff, brown, low plastic, Silty CLAY	CL
10	Becoming more plastic	
15	Very stiff to hard, brown, medium to highly plastic CLAY	CH
20	Hard, tan-gray, highly plastic CLAY with shale fragments	
25		

PIEZOMETER

Type of Piezometer PVC Observation Well



Remarks Bottom of boring: 21.5'

Inspected By P. J. Knotts

WOODWARD – CLYDE CONSULTANTS

APPENDIX C

SLUG TEST DATA

Well OWC-6

$r_w = 0.333$ ft
$r_c = 0.167$ ft
$L = 17.0$ ft
$D = 24.9$ ft
$H = 20.9$ ft

@ $t = 350$ sec $\quad y_t = 0.122$ ft

$y_o = 1.71$ ft (calc.), 1.74 ft (graphical)

$\ln [(D-H)/r_w] = 2.49$ $\quad$ if $\ln[\ ] > 6$ then $= 6$

$L/r_w = \frac{17 \text{ ft}}{0.333 \text{ ft}} = 51$ $\quad$ @ 51 $\quad A = 3.1 \quad B = 0.50 \quad C =$

$$\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln(H/r_w)} + \frac{A + B \ln[(D-H)/r_w]}{L/r_w}\right]^{-1}$$

$$\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w}\right]^{-1} \quad (\text{where } D = H)$$

$$\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln\left(\frac{20.9}{0.333}\right)} + \frac{(3.1 + 0.5 \cdot 2.60)}{51}\right]^{-1} \text{ or } \left[\frac{1.1}{\ln(\ /\ )} + \frac{\ }{\ /\ }\right]$$

$\ln \frac{R_e}{r_w} = 2.83$

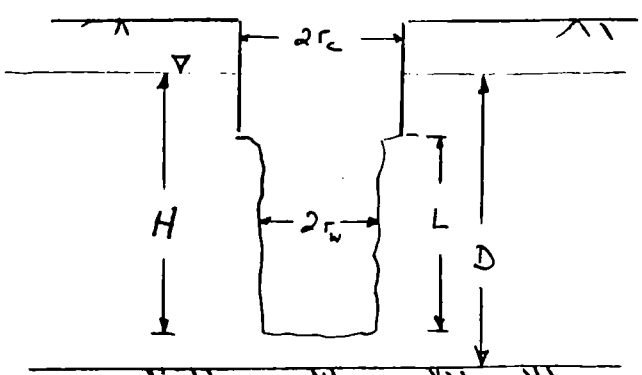
$$k = \frac{r_c^2}{2Lt} \ln \frac{R_e}{r_w} \ln \frac{y_t}{y_o} \times 646{,}272 \ \frac{\text{sec-gal}}{\text{day-ft}^3}$$

$$= \frac{(0.167 \text{ ft})^2}{2 \cdot 17 \text{ ft} \cdot 350 \text{ sec}} \cdot 2.83 \cdot \ln\left(\frac{0.122 \text{ ft}}{1.74 \text{ ft}}\right) \cdot 646{,}272 \ \frac{\text{sec-gal}}{\text{day-ft}^3}$$

$= +11.39$ gpd/ft^2 $= 1.50$ ft/day $\approx 5 \times 10^{-4}$ cm/sec

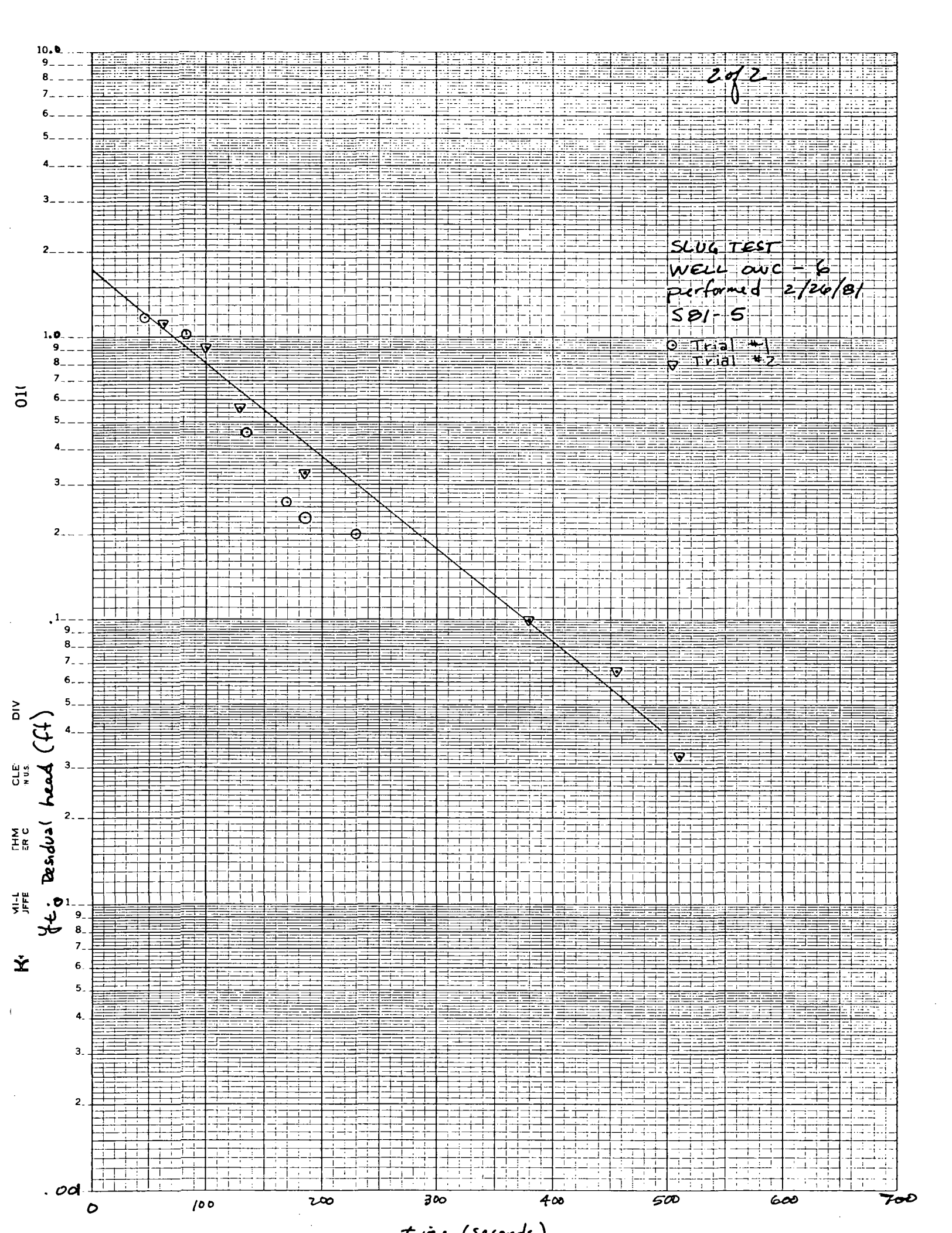
$T = k \cdot D$

≈ 280 gpd/ft



JOB S81-5 CALC: SLUG TEST UNCONFINED SHT. 1 OF 2

BY P Knuttle DATE ____ CHKD BY JPS DATE 5/29/91 JOB NO. ____


2 of 2
SLUG TEST
WELL OWC - 6
performed 2/26/81
SB1-5
Trial #1
Trial #2
Residual head (ft)
time (seconds)
0
100
200
300
400
500
600
700
10.0
9
8
7
6
5
4
3
2
1.0
.1
.01

Well OWC-7

$r_w = 0.333$ ft
$r_c = 0.167$ ft
$L = 10.0$ ft
$D = 27.8$ ft
$H = 11.8$ ft

@ $t = 300$ sec $\quad y_t = 1.21$ ft

$y_o = 1.71$ ft (calc.), 1.67 ft (graphical)

$\ln [(D-H)/r_w] = 3.84$ if $\ln[\ ] > 6$ then $= 6$

$L/r_w = \frac{10 \text{ ft}}{.333 \text{ ft}} = 30.03$ @ $A = 2.5$ $B = 0.38$ $C =$

$$\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln(H/r_w)} + \frac{A + B \ln[(D-H)/r_w]}{L/r_w}\right]^{-1}$$

$$\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w}\right]^{-1} \quad (\text{where } D = H)$$

$$\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln\left(\frac{11.8}{.333}\right)} + \frac{(2.5 + 0.38 \cdot 3.84)}{30.03}\right]^{-1} \text{ or } \left[\frac{1.1}{\ln(\ /\ )} + \frac{\ }{\ /\ }\right]$$

$\ln \frac{R_e}{r_w} = 2.24$

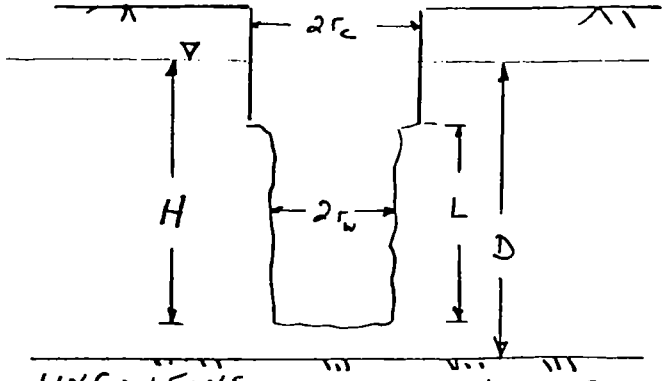
$$k = \frac{r_c^2}{2Lt} \ln \frac{R_e}{r_w} \ln \frac{y_t}{y_o} \times 646{,}272 \ \frac{\text{sec-gal}}{\text{day-ft}^3}$$

$$= \frac{(0.167 \text{ ft})^2}{2 \cdot 10 \text{ ft} \cdot 300 \text{ sec}} \cdot 2.24 \cdot \ln\left(\frac{1.21 \text{ ft}}{1.67 \text{ ft}}\right) \cdot 646{,}272 \ \frac{\text{sec-gal}}{\text{day-ft}^3}$$

≈ 2.17 gpd/ft^2 ≈ 0.30 ft/day $\approx 1 \times 10^{-4}$ cm/sec

$T = k \cdot D$

≈ 60 gpd/ft

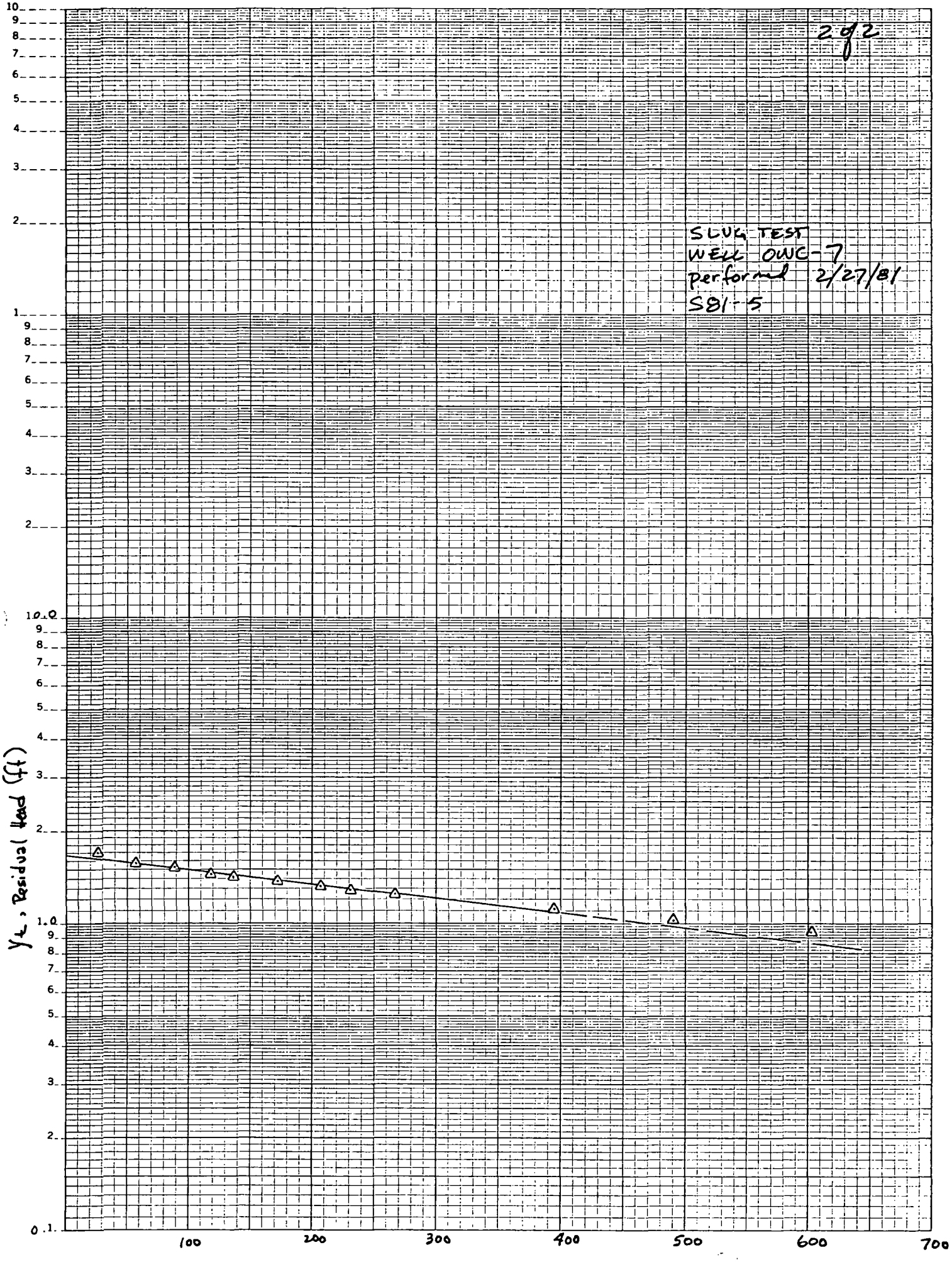


JOB 581-5 CALC: SLUG TEST UNCONFINED SHT. 1 OF 2

BY P Knotts DATE 3-3-81 CHKD BY JPS DATE 5/29/81 JOB NO.

2 of 2

SLUG TEST
WELL OWC-7
performed 2/27/81
S81-5



Well OWC-8

$r_w = 0.333$ ft
$r_c = 0.167$ ft
$L = 9.0$ ft
$D = 27.9$ ft
$H = 22.9$ ft

@ $t = 1600$ sec $\quad y_t = 1.1$ ft

$y_o = 1.71$ ft (calc.), 1.69 ft (graphically)

$\ln [(D-H)/r_w] = 2.71$ if $\ln[\ ] > 6$ then $= 6$

$L/r_w = \frac{10 \text{ ft}}{.333 \text{ ft}} = 30.03$ @ $A = 2.50$ $B = 0.38$ $C =$

$$\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln(H/r_w)} + \frac{A + B \ln[(D-H)/r_w]}{L/r_w}\right]^{-1}$$

$$\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w}\right]^{-1} \quad (\text{where } D = H)$$

$$\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln\left(\frac{18.3}{.333}\right)} + \frac{(2.5 + 0.38 \cdot 4.41)}{30.03}\right]^{-1} \text{ or } \left[\frac{1.1}{\ln(\ /\ )} + \frac{\ }{\ /\ }\right]$$

$\ln \frac{R_e}{r_w} = 2.56$

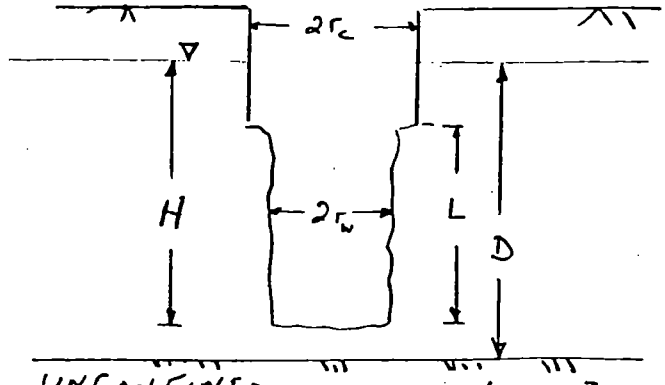
$$k = \frac{r_c^2}{2Lt} \ln \frac{R_e}{r_w} \ln \frac{y_t}{y_o} \times 646{,}272 \frac{\text{sec-gal}}{\text{day-ft}^3}$$

$$= \frac{(0.167 \text{ ft})^2}{2 \cdot 10 \text{ ft} \cdot 1600 \text{ sec}} \cdot 2.56 \cdot \ln\left(\frac{1.1 \text{ ft}}{1.70 \text{ ft}}\right) \cdot 646{,}272 \frac{\text{sec-gal}}{\text{day-ft}^3}$$

$= 0.69$ gpd/ft^2 $= 0.09$ ft/day $\approx 3 \times 10^{-5}$ cm/sec

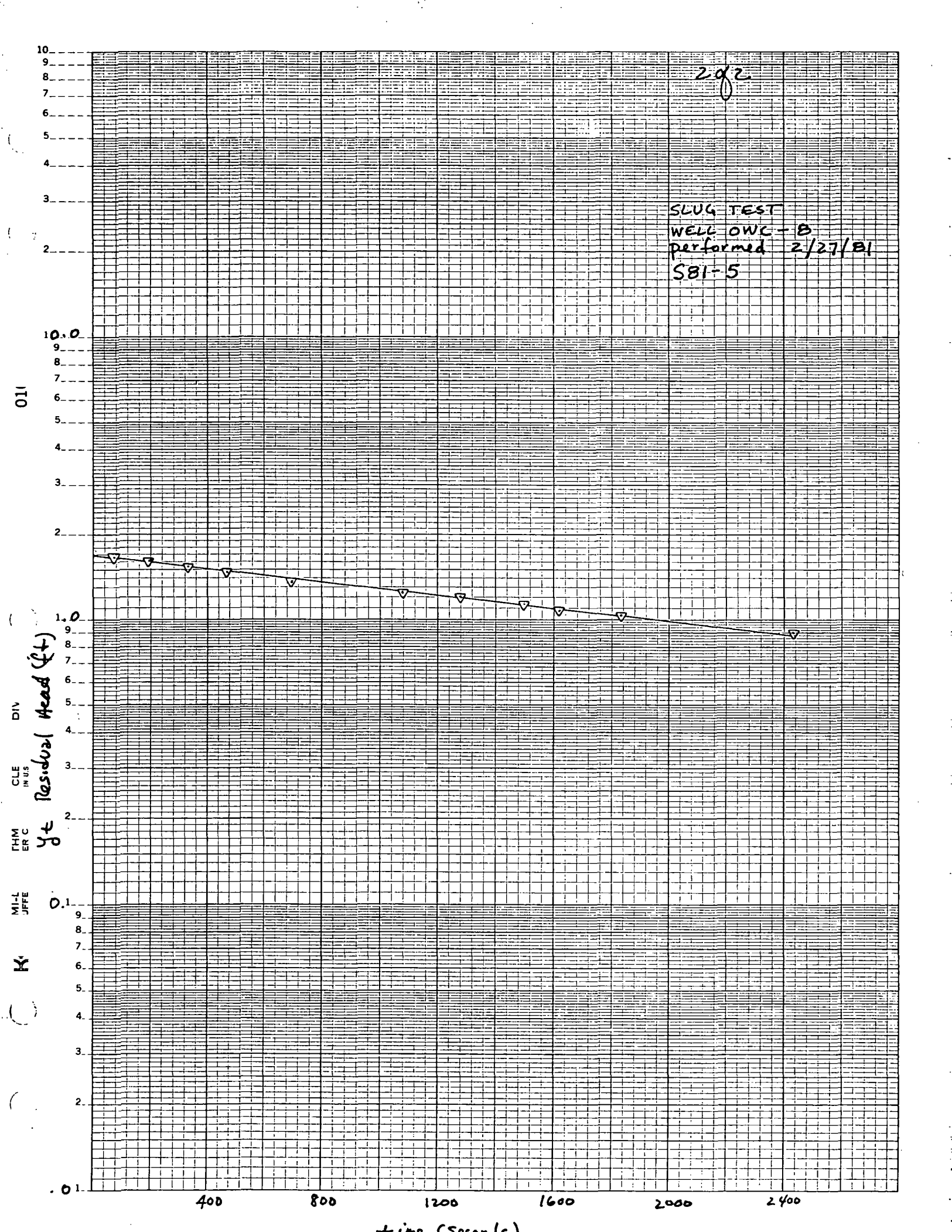
$T = k \cdot D$

≈ 19 gpd/ft



JOB S81-5 CALC: SLUG TEST, UNCONFINED SHT. 1 OF 2

BY P Knotts DATE CHKD BY JPS DATE 5/29/91 JOB NO.


2 of 2
SLUG TEST
WELL OWC-B
performed 2/27/81
S81-5
Yt Residual Head (ft)
time (Seconds)
10
9
8
7
6
5
4
3
2
10.0
1.0
0.1
.01
400
800
1200
1600
2000
2400

Well OWC-9

$r_w = 0.333$ ft
$r_c = 0.167$ ft
$L = 20.0$ ft
$D = 41.8$ ft
$H = 29.8$ ft

@ $t = 400$ sec $\quad y_t = 1.0$ ft

$y_o = 1.71$ ft (calc.), 1.57 ft (graphically)

$\ln [(D-H)/r_w] = 3.58$ $\quad$ if $\ln[\ ] > 6$ then $= 6$

$L/r_w = \frac{20 \text{ ft}}{.333 \text{ ft}} = 60.06$ @ $\quad A = 3.4 \quad B = 0.51 \quad C$

$$\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln(H/r_w)} + \frac{A + B \ln[(D-H)/r_w]}{L/r_w} \right]^{-1}$$

$$\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w} \right]^{-1} \quad (\text{where } D = H)$$

$$\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln\left(\frac{29.8}{.333}\right)} + \frac{(3.4 + 0.51 \cdot 3.58)}{60.06} \right]^{-1} \text{ or } \left[\frac{1.1}{\ln(\ /\ )} + \frac{\ }{\ /\ } \right]$$

$\ln \frac{R_e}{r_w} = 3.00$

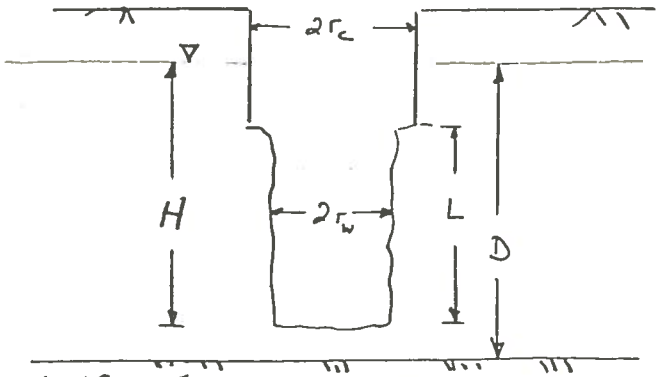
$$k = \frac{r_c^2}{2Lt} \ln \frac{R_e}{r_w} \ln \frac{y_t}{y_o} \times 646{,}272 \ \frac{\text{sec-gal}}{\text{day-ft}^3}$$

$$= \frac{(0.167 \text{ ft})^2}{2 \cdot 20 \text{ ft} \cdot 400 \text{ sec}} \cdot 3.00 \cdot \ln\left(\frac{1.0 \text{ ft}}{1.6 \text{ ft}}\right) \cdot 646{,}272 \ \frac{\text{sec-gal}}{\text{day-ft}^3}$$

$= 1.59$ gpd/ft^2 $= 0.21$ ft/day $\approx 7 \times 10^{-5}$ cm/sec

$T = k \cdot D$

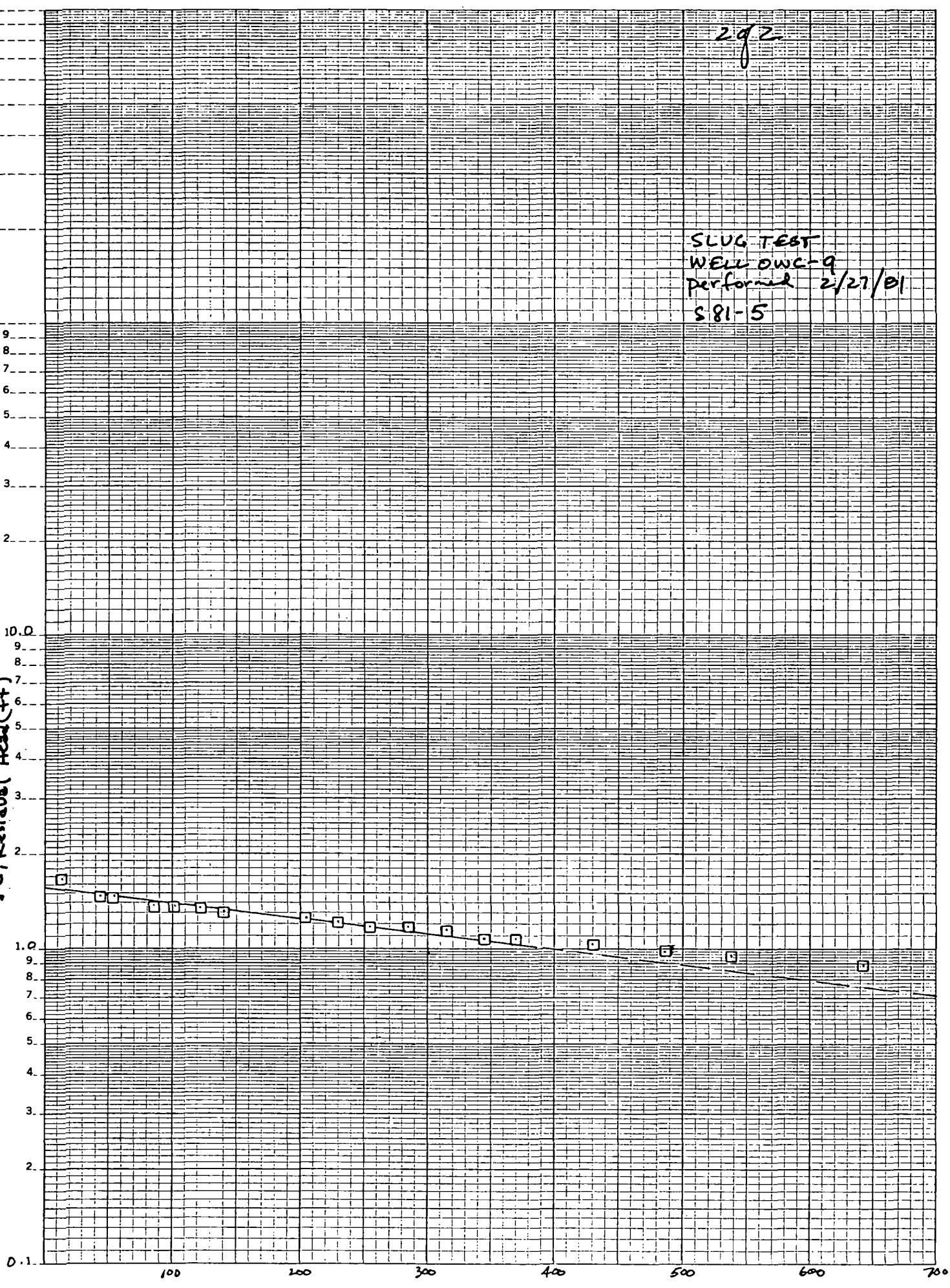
≈ 65 gpd/ft



JOB S81-5 CALC: SLUG TEST, UNCONFINED SHT. 1 OF 2

BY P Kmetta DATE CHKD BY JRB DATE 5/29/81 JOB NO.

SLUG TEST
WELL OWC-9
Performed 2/27/81
S81-5



Well OWC-15

$r_w = 0.333$ ft
$r_c = 0.167$ ft
$L = 10.0$ ft
$D = 20.0$ ft
$H = 12.5$ ft

@ $t = 200$ sec $\quad y_t = 0.22$ ft

$y_o = 1.71$ ft (calc.), 1.86 ft (graphical)

$\ln [(D-H)/r_w] = 3.11$ $\quad$ if $\ln[\ ] > 6$ then $= 6$

$L/r_w = \frac{10 \text{ ft}}{.333 \text{ ft}} = 30.03$ @ $\quad A = 2.5 \quad B = 0.38 \quad C =$

$$\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln(H/r_w)} + \frac{A + B \ln[(D-H)/r_w]}{L/r_w} \right]^{-1}$$

$$\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w} \right]^{-1} \quad (\text{where } D = H)$$

$$\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln\left(\frac{12.5}{.333}\right)} + \frac{(2.5 + 0.38 \cdot 2.97)}{30.03} \right]^{-1} \text{ or } \left[\frac{1.1}{\ln(\ /\ )} + \frac{\ }{\ /\ } \right]$$

$\ln \frac{R_e}{r_w} = 2.36$

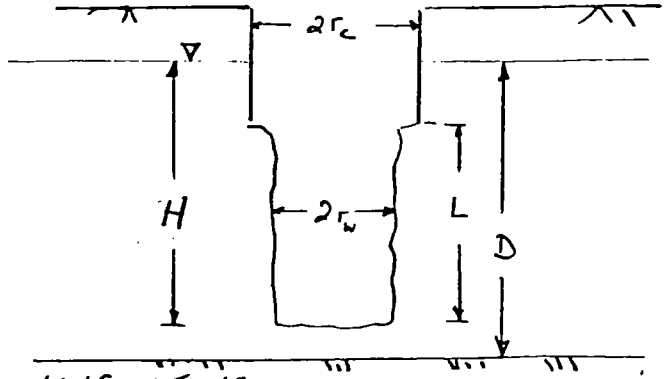
$$k = \frac{r_c^2}{2Lt} \ln \frac{R_e}{r_w} \ln \frac{y_t}{y_o} \times 646,272 \ \frac{\text{sec-gal}}{\text{day-ft}^3}$$

$$= \frac{(0.167 \text{ ft})^2}{2 \cdot 10 \text{ ft} \cdot 200 \text{ sec}} \cdot 2.36 \cdot \ln\left(\frac{0.22 \text{ ft}}{1.86 \text{ ft}}\right) \cdot 646,272 \ \frac{\text{sec-gal}}{\text{day-ft}^3}$$

$= 22.7$ gpd/ft^2 ≈ 3.0 ft/day $\approx 1 \times 10^{-3}$ cm/sec

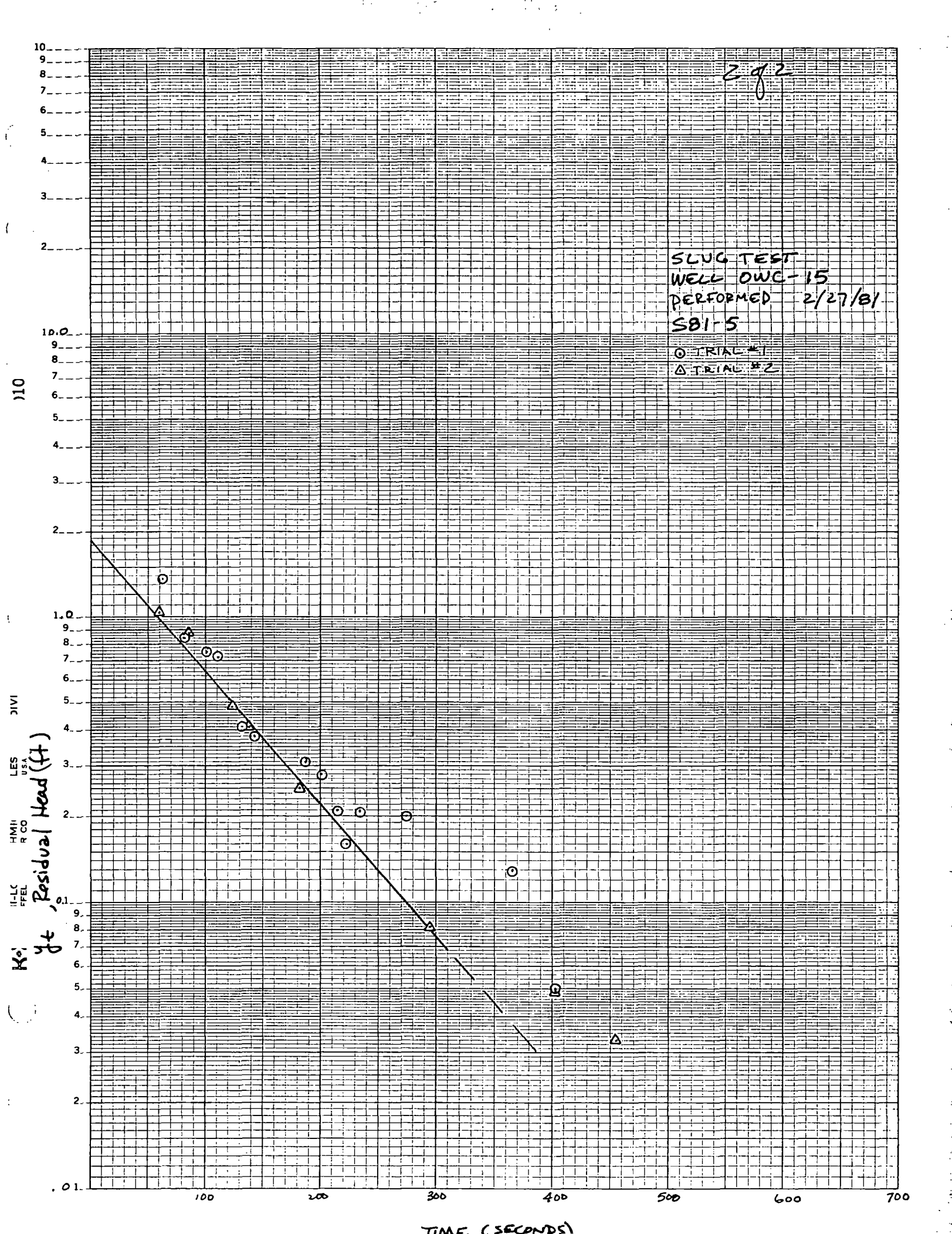
$T = k \cdot D$

≈ 454 gpd/ft



JOB 581-5 CALC: SLUG TEST UNCONFINED SHT. 1 OF 2

BY D Cutter DATE CHKD BY JFS DATE 5/29/91 JOB NO.


2 of 2
SLUG TEST
WELL OWC-15
PERFORMED 2/27/81
S81-5
⊙ TRIAL #1
△ TRIAL #2
Ho/Ht, Residual Head (ft)
TIME (SECONDS)
10
9
8
7
6
5
4
3
2
1.0
0.1
.01
100
200
300
400
500
600
700

APPENDIX D

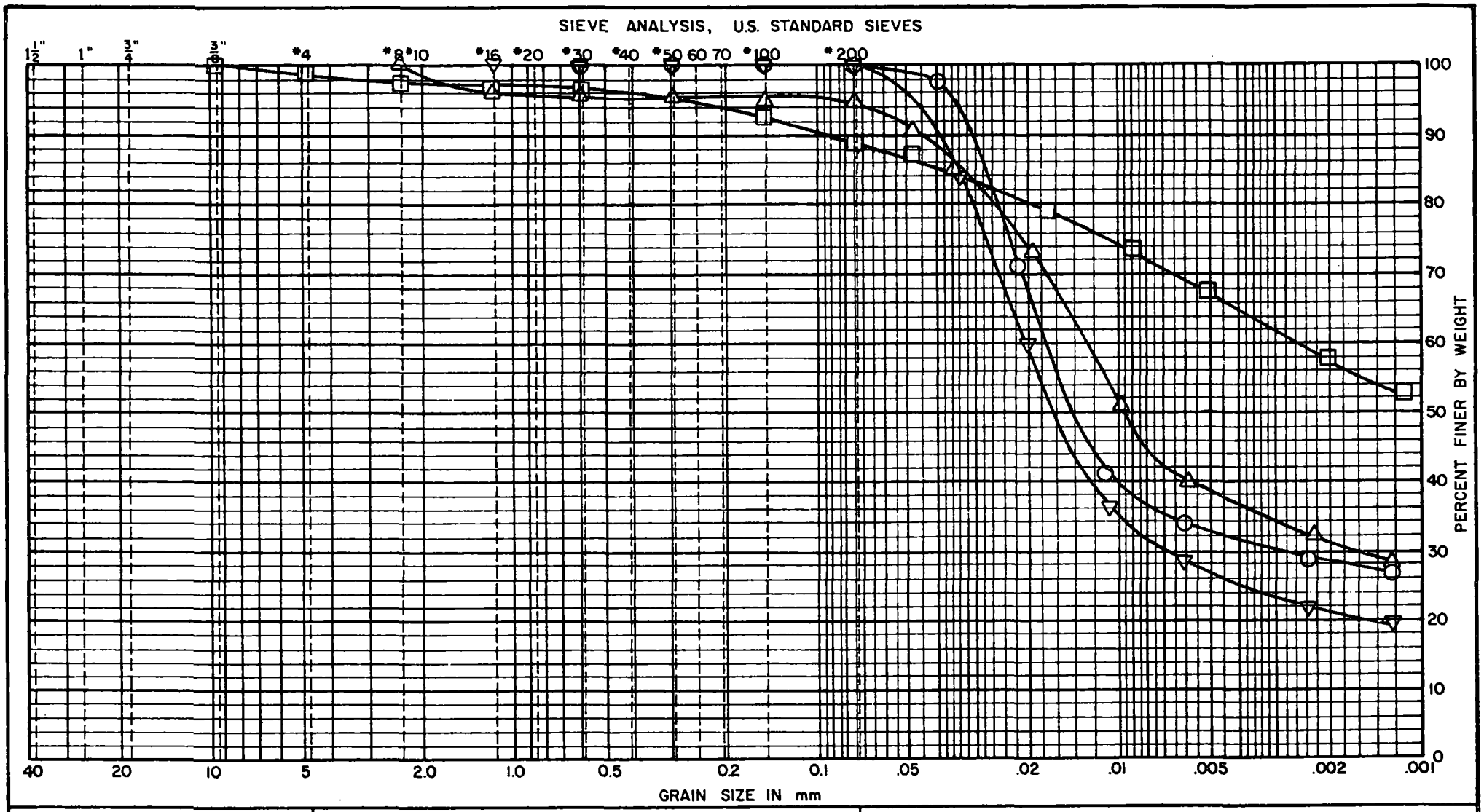
ENGINEERING INDEX SUMMARY TABLE AND GRAIN SIZE CURVES

TABLE D-1

SUMMARY OF LABORATORY TEST DATA

ORTHO-CHEVRON
ST. LOUIS, MISSOURI
S81-5

BORING OR TEST PIT NUMBER	SAMPLE DEPTH, ft.	UNIFIED SOIL CLASSIFICATION SYMBOL	CLASSIFICATION PROPERTIES						PHYSICAL PROPERTIES										
									COMPRESSIVE STRENGTH						VOLUME CHANGE				
									UNCONFINED			TRIAXIAL							
			AVERAGE NATURAL WATER CONTENT, %	DRY UNIT WEIGHT, pcf	LIQUID LIMIT, %	PLASTIC LIMIT, %	LIMIT SAMPLE WATER CONTENT, %	GRAIN SIZE DATA - FIGURE	COMPRESSIVE STRENGTH, ksf	WATER CONTENT AT END OF TEST, %	STRAIN AT FAILURE, %	TRIAXIAL DATA - FIGURE	TYPE OF TEST	WATER CONTENT START - END, %	VOLUME CHANGE DATA - FIGURES	EXISTING OVERBURDEN STRESS, ksf	ESTIMATED PRECONSOL-IDATION STRESS, ksf	VOLUME CHANGE, INUN-DATED @ 1 psi, %	SWELL PRESSURE MAXIMUM - CONFINED INNUNDATED, psi
OWC-5	1	CL	24		41	20		D-1											
	7	CL	25		48	20		D-1											
	15	CL	27		32	19		D-1											
	25	CH	26		63	23		D-1											



GRAVEL		SAND			CLAY OR SILT
COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	BORING NO.	DEPTH	DESCRIPTION OF SAMPLE	
○	OWC-5	3'	BROWN SILTY CLAY	(CL)
△		7'	GRAY-BLACK SILTY CLAY WITH SAND	(CL)
▽		15'	BROWN SILTY CLAY	(CL)
□		25'	YELLOW-TAN CLAY WITH SAND	(CH)

ORTHO - CHEVRON
ST. LOUIS, MISSOURI
ORTHO - CHEVRON CHEMICAL CO.

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS
AND ENVIRONMENTAL SCIENTISTS
CENTRAL REGION

DRAWN BY: J.G. 3-20-81
CHECKED BY:

PROJECT NO. S81-5

GRADATION CURVES

FIG. NO. D-1

APPENDIX E

EPA HAZARDOUS WASTE ANALYSIS REPORT FORM

WILSON LABORATORIES
ANALYTICAL & RESEARCH CHEMISTS & BIOLOGISTS
A DIVISION OF WILSON & COMPANY, ENGINEERS & ARCHITECTS

528 NORTH NINTH • SALINA, KANSAS 67401 • LAB: (913) 825-7186 OFFICE: (913) 827-0433

LABORATORY REPORT

Waste Generator: Chevron Ortho Division

Location of Waste Generation:

Process Producing Waste:

Description of Waste:

Quantity of Waste Produced:

Average Monthly -

Maximum Monthly -

Annual -

Wastes produced but not covered by these tests: (If any other wastes are known to be produced by the same process but are not being analyzed, they should be described).

Parameter(s) being tested: EP (Extraction Procedure) Toxicity Test for Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, Silver, Toxaphene, Lindane, Methoxychlor, 2,4-D, and 2,4,5-TP, as per "Hazardous Waste Management System", Federal Register, 45(98), May 19, 1980.

Samples were collected on Feb. 24 and 27, 1981 by Peter Barrett and Philip Knotts of Woodward-Clyde Consultants, St. Louis, Missouri.

Analysis portion of EP Toxicity Test was completed on 12 March 1981, according to "Hazardous Waste Management System", Federal Register, 45(98); 33127-33128, May 19, 1980.

These wastes do not exhibit the characteristics of EP Toxicity as defined in and tested according to "Hazardous Waste Management System", Federal Register, 45(98), May 19, 1980.

File No. 81-9521
Lab No. 8103-0184E, S81-5 Dirt Pile; 8103-0213E, S81-5 B212 7 ft. 3-3,4
8103-0213E
S81-5 B212 3 ft. 1-3,4
Date: 13 March 1981

APPENDIX F

GROUNDWATER CHEMISTRY RESULTS

TABLE F-1
CHEMICAL ANALYSES

Observation Well: OWC - 1

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-27-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-26-81

Time Sampled: 10:45

ANALYSIS	CONCENTRATION	UNITS	ANALYST	BOOK/PAGE
LAB NUMBER: 8102-0779A SAMPLE DESCRIPTION: OWC-1 SPECIAL INSTRUCTIONS: NO PREP				
DATE SAMPLED	2/26/81			/
TIME SAMPLED	1045			/
ALKALINITY, TOTAL		MG/L, AS CACO3		/
CALCIUM, BY EDTA TITRATION	112	MG/L	CJA	82 / 32
CHLORIDE	142	MG/L	BLB	108 / 35
FLUORIDE	0.215	MG/L	CJA	25 / 94
IRON, TOTAL		MG/L		/
MAGNESIUM		MG/L		/
MANGANESE		MG/L		/
NITRATE		MG/L AS N		/
ORTHOPHOSPHATE	ND(0.05)	MG/L AS P	BLB	128 / 9
PH	6.50		LKN	83 / 78
POTASSIUM		MG/L		/
SILICON		MG/L		/
SODIUM		MG/L		/
SPECIFIC CONDUCTANCE	1210	UMHOS/CM	MJB	124 / 11
SULFATE		MG/L		/
TOTAL ORGANIC CARBON	2.6	MG/L	GMD	85 / 69
--CONCLUSION--LAB NUMBER: 8102-0779A				
LAB NUMBER: 8102-0779B SAMPLE DESCRIPTION: OWC-1 SPECIAL INSTRUCTIONS: FILTER GLASS FIBER				
ALDRIN	0.12	UG/L	CJB	132 / 21
CHLORDANE	ND(1.0)	UG/L	CJB	132 / 21
4,4-DDD	ND(0.20)	UG/L	CJB	132 / 21
4,4-DDE	ND(0.20)	UG/L	CJB	132 / 21
4,4-DDT	ND(0.30)	UG/L	CJB	132 / 21
DIELDRIN	ND(0.20)	UG/L	CJB	132 / 21
ENDRIN	ND(0.40)	UG/L	DKS	132 / 21
HEPTACHLOR	ND(0.10)	UG/L	CJB	132 / 21
MALATHION	ND(2.0)	UG/L	CJB	132 / 23
SEVIN	NOT ANAL.	UG/L	CJB	132 / 21
2,4,5-T	ND(1.1)	UG/L	CJB	132 / 22
TOXAPHENE	ND(10.0)	UG/L	CJB	132 / 21
PCB	ND(10.0)	UG/L	CJB	132 / 21
LINDANE	0.26	UG/L	CJB	132 / 21
METHOXYCHLOR	ND(0.8)	UG/L	CJB	132 / 21
2,4-D	1.8	UG/L	CJB	132 / 21
MIREX	ND(0.5)	UG/L	CJB	132 / 21
CAPTAN	ND(0.20)	UG/L	CJB	132 / 21
DIFOLATAN	ND(20)	UG/L	CJB	132 / 21
CHLOROBENZILATE	ND(0.30)	UG/L	CJB	132 / 21
GUTHION	ND(100)	UG/L	CJB	132 / 23
DIAZINON	ND(0.5)	UG/L	CJB	132 / 23
PARATHION, METHYL	ND(2.0)	UG/L	CJB	132 / 23
PARATHION, ETHYL	ND(0.5)	UG/L	CJB	132 / 23
TRITHION	NOT ANAL.	UG/L	CJB	132 / 21
PHOSDRIN (MEVINPHOS)	ND(2.0)	UG/L	CJB	132 / 23
--CONCLUSION--LAB NUMBER: 8102-0779B				
LAB NUMBER: 8102-0779C SAMPLE DESCRIPTION: OWC-1 SPECIAL INSTRUCTIONS: FILTERED IN FIELD				
ARSENIC	0.010	MG/L	BTF	131 / 54
CADMIUM	0.0005	MG/L	BTF	131 / 57
COPPER	0.0027	MG/L	BTF	131 / 56
ZINC	0.05	MG/L	BTF	131 / 53
--CONCLUSION--LAB NUMBER: 8102-0779C				

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-1
CHEMICAL ANALYSES

Observation Well: OWC - 1

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-27-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-26-81

Time Sampled: 10:45

STANDARD CHEMICAL WATER ANALYSIS

DATE: 13 MARCH 1981

LABORATORY FILE NO.: 81-9521
LABORATORY NO.: 8102-0779A
SAMPLE RECEIVED 27 FEBRUARY 1981

			LABORATORY ANALYSIS
CATIONS			
CALCIUM	CA+2	MG/L	112.00
IRON	FE+2	MG/L	0.10
MAGNESIUM	MG+2	MG/L	42.70
MANGANESE	MN+2	MG/L	0.00
POTASSIUM	K +1	MG/L	1.90
SODIUM	NA+1	MG/L	45.00
ANIONS			
BICARBONATE	HCO3-1	MG/L	256.03
CARBONATE	CO3 -2	MG/L	0.08
CHLORIDE	CL -1	MG/L	142.00
FLUORIDE	F- -1	MG/L	0.22
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	11.52
PHOSPHATE	PO4 -3	MG/L	0.00
SULFATE	SO4 -2	MG/L	140.00
SILICATE	SIO4-4	MG/L	0.03
SILICA		SIO2 MG/L	40.66
TOTAL FREE CARBON DIOXIDE		CO2 MG/L	287.03
EQUILIBRIUM CARBON DIOXIDE		CO2 MG/L	37.09
TOTAL DISSOLVED SOLIDS (CALC)			MG/L 788.03
TOTAL ALKALINITY		AS CACO3	MG/L 209.94
CALCIUM ALKALINITY		AS CACO3	MG/L 209.94
MAGNESIUM ALKALINITY		AS CACO3	MG/L 0.00
SODIUM ALKALINITY		AS CACO3	MG/L 0.00
TOTAL HARDNESS		AS CACO3	MG/L 455.07
CALCIUM HARDNESS		AS CACO3	MG/L 280.00
MAGNESIUM HARDNESS		AS CACO3	MG/L 175.50
NON CARBONATE HARDNESS		AS CACO3	MG/L 245.13
CALCIUM NON-CARBONATE HARDNESS			MG/L 70.06
MAGNESIUM NON CARBONATE HARDNESS			MG/L 175.50
PH		PH UNITS	6.53
EQUILIBRIUM PH (CALC)		PH UNITS	7.21
STABILITY INDEX		PH UNITS	7.93
SATURATION INDEX		PH UNITS	-0.71
TEMPERATURE		DEGREES FAHRENHEIT	68.00
CONDUCTIVITY MEASURED		MICROMHOS/CM	1210.00
IONIC STRENGTH (MOLAR)			0.0172
ION BALANCE ERROR (PERCENT) BY CONCENTRATION			-0.92

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-2
CHEMICAL ANALYSES

Observation Well: OWC - 3

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-27-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-26-81

Time Sampled: 11:15

ANALYSIS	CONCENTRATION	UNITS	ANALYST	BOOK/PAGE
LAB NUMBER: 8102-0780A SAMPLE DESCRIPTION: OWC-3 SPECIAL INSTRUCTIONS: NO PREP				
DATE SAMPLED	2/26/81			/
TIME SAMPLED	1115			/
ALKALINITY, TOTAL		MG/L, AS CACO3	/	
CALCIUM, BY EDTA TITRATION	129	MG/L	CJA	82 / 32
CHLORIDE	284	MG/L	BLH	100 / 35
FLUORIDE	0.135	MG/L	CJA	85 / 94
IRON, TOTAL		MG/L	/	
MAGNESIUM		MG/L	/	
MANGANESE		MG/L	/	
NITRATE		MG/L AS N	/	
ORTHOPHOSPHATE	ND(0.05)	MG/L AS P	BLD	128 / 9
PH	6.55	-	LKN	83 / 78
POTASSIUM		MG/L	/	
SILICON		MG/L	/	
SODIUM		MG/L	/	
SPECIFIC CONDUCTANCE	1590	UMHOS/CM	MJB	124 / 11
SULFATE		MG/L	/	
TOTAL ORGANIC CARBON	2.5	MG/L	GMD	85 / 69
--CONCLUSION--LAB NUMBER: 8102-0780A				
LAB NUMBER: 8102-0780B SAMPLE DESCRIPTION: OWC-3 SPECIAL INSTRUCTIONS: FILTER GLASS FIBER				
ALDRIN	ND(0.12)	UG/L	CJB	132 / 21
CHLORDANE	ND(1.0)	UG/L	CJB	132 / 21
4,4-DDD	ND(0.20)	UG/L	CJB	132 / 21
4,4-DDE	ND(0.20)	UG/L	CJB	132 / 21
4,4-DDT	ND(0.30)	UG/L	CJB	132 / 21
DIELDRIN	ND(0.20)	UG/L	CJB	132 / 21
ENDRIN	ND(0.40)	UG/L	BKS	132 / 21
HEPTACHLOR	ND(0.10)	UG/L	CJB	132 / 21
MALATHION	ND(2.0)	UG/L	CJB	132 / 23
SEVIN	NOT ANAL.	UG/L	CJB	132 / 21
2,4,5-T	0.1	UG/L	CJB	132 / 22
TOXAPHENE	ND(10.0)	UG/L	CJB	132 / 21
PCB	ND(10.0)	UG/L	CJB	132 / 21
LINDANE	1.07	UG/L	CJB	132 / 21
METHOXYCHLOR	ND(0.8)	UG/L	CJB	132 / 21
2,4-D	ND(1.0)	UG/L	CJB	132 / 21
MIREX	ND(0.5)	UG/L	CJB	132 / 21
CAPTAN	ND(0.20)	UG/L	CJB	132 / 21
DIFOLATAN	ND(20)	UG/L	CJB	132 / 21
CHLOROBENZILATE	ND(0.30)	UG/L	CJB	132 / 21
GUTHION	ND(100)	UG/L	CJB	132 / 23
DIAZINON	1.7	UG/L	CJB	132 / 23
PARATHION, METHYL	ND(2.0)	UG/L	CJB	132 / 23
PARATHION, ETHYL	ND(0.5)	UG/L	CJB	132 / 23
TRITHION	NOT ANAL.	UG/L	CJB	132 / 21
PHOSDRIN (MEVINPHOS)	ND(2.0)	UG/L	CJB	132 / 23
--CONCLUSION--LAB NUMBER: 8102-0780B				
LAB NUMBER: 8102-0780C SAMPLE DESCRIPTION: OWC-3 SPECIAL INSTRUCTIONS: FILTERED IN FIELD				
ARSENIC	0.024	MG/L	BTF	131 / 54
CADMIUM	0.0006	MG/L	BTF	131 / 57
COPPER	0.0069	MG/L	BTF	131 / 56
ZINC	0.04	MG/L	BTF	131 / 53
--CONCLUSION--LAB NUMBER: 8102-0780C				

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-2
CHEMICAL ANALYSES

Observation Well: OWC - 3

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-27-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-26-81

Time Sampled: 11:15

STANDARD CHEMICAL WATER ANALYSIS

DATE: 13 MARCH 1981

LABORATORY FILE NO.: 81-9521
LABORATORY NO.: 8102-0780A
SAMPLE RECEIVED 27 FEBRUARY 1981

CATIONS			LABORATORY ANALYSIS
CALCIUM	CA+2	MG/L	129.00
IRON	FE+2	MG/L	0.05
MAGNESIUM	MG+2	MG/L	38.00
MANGANESE	MN+2	MG/L	0.24
POTASSIUM	K +1	MG/L	0.90
SODIUM	NA+1	MG/L	90.00
ANIONS			
BICARBONATE	HCO3-1	MG/L	158.45
CARBONATE	CO3 -2	MG/L	0.06
CHLORIDE	CL -1	MG/L	284.00
FLUORIDE	F- -1	MG/L	0.14
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	7.97
PHOSPHATE	PO4 -3	MG/L	0.00
SULFATE	SO4 -2	MG/L	115.00
SILICATE	SIO4-4	MG/L	0.03
SILICA	SIO2	MG/L	34.24
TOTAL FREE CARBON DIOXIDE	CO2	MG/L	160.73
EQUILIBRIUM CARBON DIOXIDE	CO2	MG/L	16.06
TOTAL DISSOLVED SOLIDS (CALC)		MG/L	855.48
TOTAL ALKALINITY	AS CACO3	MG/L	129.94
CALCIUM ALKALINITY	AS CACO3	MG/L	129.94
MAGNESIUM ALKALINITY	AS CACO3	MG/L	0.00
SODIUM ALKALINITY	AS CACO3	MG/L	0.00
TOTAL HARDNESS	AS CACO3	MG/L	478.15
CALCIUM HARDNESS	AS CACO3	MG/L	322.50
MAGNESIUM HARDNESS	AS CACO3	MG/L	156.18
NON-CARBONATE HARDNESS	AS CACO3	MG/L	348.21
CALCIUM NON-CARBONATE HARDNESS		MG/L	192.56
MAGNESIUM NON-CARBONATE HARDNESS		MG/L	156.18
PH	PH UNITS		6.55
EQUILIBRIUM PH (PHS)	PH UNITS		7.37
STABILITY INDEX	PH UNITS		8.18
SATURATION INDEX	PH UNITS		-0.82
TEMPERATURE DEGREES FAHRENHEIT			68.00
CONDUCTIVITY, MEASURED MICROMHOS/CM			1590.00
IONIC STRENGTH (MOLAR)			0.0193
ION BALANCE ERROR (PERCENT) BY CONCENTRATION			1.39

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-3
CHEMICAL ANALYSES

Observation Well: OWC - 4

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-26-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-24-81

Time Sampled: 16:00

ANALYSIS	CONCENTRATION	UNITS	ANALYST	BOOK/PAGE
LAB NUMBER: 8102-0699A SAMPLE DESCRIPTION: OWC-4 CHEVRON SPECIAL INSTRUCTIONS: FILTER GLASS FIBER				
DATE SAMPLED	2/24/81			/
TIME SAMPLED	16:00			/
ALDRIN	ND(0.12)	UG/L	CJB	132 / 21
CHLORDANE	ND(1.0)	UG/L	CJB	132 / 21
4,4-DDD	ND(0.20)	UG/L	CJB	132 / 21
4,4-DDE	ND(0.20)	UG/L	CJB	132 / 21
4,4-DDT	ND(0.30)	UG/L	CJB	132 / 21
DIELDRIN	ND(0.20)	UG/L	CJB	132 / 21
ENDRIN	ND(0.40)	UG/L	BKS	132 / 21
HEPTACHLOR	1.76	UG/L	CJB	132 / 21
MALATHION	ND(2.0)	UG/L	CJB	132 / 23
SEVIN	NOT ANAL.	UG/L	CJB	132 / 21
2,4,5-T	1.9	UG/L	CJB	132 / 22
TOXAPHENE	ND(10.0)	UG/L	CJB	132 / 21
PCB	ND(10.0)	UG/L	CJB	132 / 21
LINDANE	1.25	UG/L	CJB	132 / 21
METHOXYCHLOR	ND(0.8)	UG/L	CJB	132 / 21
2,4-D	47	UG/L	CJB	132 / 21
MIREX	3.07	UG/L	CJB	132 / 21
CAPTAN	ND(0.20)	UG/L	CJB	132 / 21
DIFOLATAN	ND(20)	UG/L	CJB	132 / 21
CHLOROBENZILATE	ND(0.30)	UG/L	CJB	132 / 21
GUTHION	ND(100)	UG/L	CJB	132 / 23
DIAZINON	1.6	UG/L	CJB	132 / 23
PARATHION, METHYL	ND(2.0)	UG/L	CJB	132 / 23
PARATHION, ETHYL	ND(0.5)	UG/L	CJB	132 / 23
TRITHION	NOT ANAL.	UG/L	CJB	132 / 21
PHOSDRIN (MEVINPHOS)	ND(2.0)	UG/L	CJB	132 / 23
--CONCLUSION--LAB NUMBER: 8102-0699A				
LAB NUMBER: 8102-0699B SAMPLE DESCRIPTION: OWC-4 CHEVRON SPECIAL INSTRUCTIONS: FILTERED IN FIELD				
ARSENIC	ND(0.001)	MG/L	RTF	131 / 50
CADMIUM	0.0021	MG/L	RCR	130 / 196
COPPER	0.0023	MG/L	RCR	130 / 200
ZINC	0.048	MG/L	RCR	130 / 192
--CONCLUSION--LAB NUMBER: 8102-0699B				
LAB NUMBER: 8102-0699C SAMPLE DESCRIPTION: OWC-4 CHEVRON SPECIAL INSTRUCTIONS: NO PREP				
ALKALINITY, TOTAL	110	MG/L, AS CACO3	BLD	47 / 91
CALCIUM, BY EDTA TITRATION	183	MG/L	CJA	82 / 32
CHLORIDE	540	MG/L	BLD	108 / 35
FLUORIDE	0.11	MG/L	CJA	25 / 94
IRON, TOTAL	0.17	MG/L	RCR	130 / 186
MAGNESIUM	44	MG/L	RCR	130 / 190
MANGANESE	0.31	MG/L	RCR	130 / 186
NITRATE	2.8	MG/L AS N	CJA	109 / 32
ORTHOPHOSPHATE	0.05	MG/L AS P	BLD	128 / 9
PH	5.90		LKN	83 / 76
POTASSIUM	2.5	MG/L	RCR	130 / 188
SILICON	14	MG/L	RCR	130 / 190
SODIUM	170	MG/L	RCR	130 / 188
SPECIFIC CONDUCTANCE	2480	UMHOS/CM	MJB	124 / 10
SULFATE	75	MG/L	BLD	95 / 37
TOTAL ORGANIC CARBON	5.7	MG/L	GMD	85 / 69
--CONCLUSION--LAB NUMBER: 8102-0699C				

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-3
CHEMICAL ANALYSES

Observation Well: OWC - 4

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-26-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-24-81

Time Sampled: 16:00

STANDARD CHEMICAL WATER ANALYSIS

DATE: 13 MARCH 1981

LABORATORY FILE NO.: 81-9521
LABORATORY NO.: 8102-0699C
SAMPLE RECEIVED 26 FEBRUARY 1981

CATIONS			LABORATORY ANALYSIS
CALCIUM	CA+2	MG/L	183.00
IRON	FE+2	MG/L	0.17
MAGNESIUM	MG+2	MG/L	44.00
MANGANESE	MN+2	MG/L	0.31
POTASSIUM	K +1	MG/L	2.50
SODIUM	NA+1	MG/L	170.00
ANIONS			
BICARBONATE	HCO3-1	MG/L	134.19
CARBONATE	CO3 -2	MG/L	0.01
CHLORIDE	CL -1	MG/L	540.00
FLUORIDE	F -1	MG/L	0.11
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	12.40
PHOSPHATE	PO4 -3	MG/L	0.15
SULFATE	SO4 -2	MG/L	75.00
SILICATE	SIO4-4	MG/L	0.01
SILICA		SIO2 MG/L	29.96
TOTAL FREE CARBON DIOXIDE		CO2 MG/L	637.59
EQUILIBRIUM CARBON DIOXIDE		CO2 MG/L	16.33
TOTAL DISSOLVED SOLIDS (CALC)		MG/L	1189.62
TOTAL ALKALINITY	AS	CACO3 MG/L	109.93
CALCIUM ALKALINITY	AS	CACO3 MG/L	109.93
MAGNESIUM ALKALINITY	AS	CACO3 MG/L	0.00
SODIUM ALKALINITY	AS	CACO3 MG/L	0.00
TOTAL HARDNESS	AS	CACO3 MG/L	637.56
CALCIUM HARDNESS	AS	CACO3 MG/L	457.50
MAGNESIUM HARDNESS	AS	CACO3 MG/L	180.84
NON-CARBONATE HARDNESS	AS	CACO3 MG/L	527.63
CALCIUM NON-CARBONATE HARDNESS		MG/L	347.57
MAGNESIUM NON-CARBONATE HARDNESS		MG/L	180.84
PH		PH UNITS	5.90
EQUILIBRIUM PH (PHS)		PH UNITS	7.28
STABILITY INDEX		PH UNITS	8.66
SATURATION INDEX		PH UNITS	1.38
TEMPERATURE	DEGREES	FAHRENHEIT	69.80
CONDUCTIVITY, MEASURED	MICROMHOS/CM		2480.00
IONIC STRENGTH (MEAN)			0.0269
ION BALANCE ERROR (PERCENT) BY CONCENTRATION			2.59

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-4
CHEMICAL ANALYSES

Observation Well: OWC - 5

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-27-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-25-81

Time Sampled: 14:00

ANALYSIS	CONCENTRATION	UNITS	ANALYST	BOOK/PAGE
LAB NUMBER: 8102-0781A SAMPLE DESCRIPTION: OWC-5 SPECIAL INSTRUCTIONS: NO PREP				
DATE SAMPLED	2/25/81			/
TIME SAMPLED	1400			/
ALKALINITY, TOTAL		MG/L, AS CACO3		/
CALCIUM, BY EDTA TITRATION	134	MG/L	CJA	82 / 32
CHLORIDE	46	MG/L	BLD	108 / 35
FLUORIDE	0.135	MG/L	CJA	25 / 94
IRON, TOTAL		MG/L		/
MAGNESIUM		MG/L		/
MANGANESE		MG/L		/
NITRATE	ND(0.1)	MG/L AS N	CJA	109 / 32
ORTHOPHOSPHATE	0.30	MG/L AS P	BLD	128 / 9
PH	6.40		LKN	82 / 78
POTASSIUM		MG/L		/
SILICON		MG/L		/
SODIUM		MG/L		/
SPECIFIC CONDUCTANCE	1450	UMHOS/CM	MJB	124 / 11
SULFATE		MG/L		/
TOTAL ORGANIC CARBON	9.5	MG/L	GMD	85 / 69
--CONCLUSION--LAB NUMBER: 8102-0781A				
LAB NUMBER: 8102-0781B SAMPLE DESCRIPTION: OWC-5 SPECIAL INSTRUCTIONS: FILTER GLASS FIBER				
DATE SAMPLED	2/25/81			/
TIME SAMPLED	1400			/
ALDRIN	ND(0.12)	UG/L	CJB	132 / 21
CHLORDANE	ND(1.0)	UG/L	CJB	132 / 21
4,4-DDD	ND(0.20)	UG/L	CJB	132 / 21
4,4-DDE	ND(0.20)	UG/L	CJB	132 / 21
4,4-DDT	ND(0.30)	UG/L	CJB	132 / 21
DIELDRIN	ND(0.20)	UG/L	CJB	132 / 21
ENDRIN	ND(0.40)	UG/L	BKS	132 / 21
HEPTACHLOR	ND(0.10)	UG/L	CJB	132 / 21
MALATHION	ND(2.0)	UG/L		/
SEVIN	NOT ANAL.	UG/L	CJB	132 / 21
2,4,5-T	ND(0.1)	UG/L	CJB	132 / 22
TOXAPHENE	ND(10.0)	UG/L	CJB	132 / 21
PCB	ND(10.0)	UG/L	CJB	132 / 21
LINDANE	0.29	UG/L	CJB	132 / 21
METHOXYCHLOR	ND(0.8)	UG/L	CJB	132 / 21
2,4-D	ND(1.0)	UG/L	CJB	132 / 21
MIREX	ND(0.5)	UG/L	CJB	132 / 21
CAPTAN	ND(0.20)	UG/L	CJB	132 / 21
DIFOLATAN	ND(20)	UG/L	CJB	132 / 21
CHLOROBENZILATE	ND(5.30)	UG/L	CJB	132 / 21
GUTHION	ND(100)	UG/L	CJB	132 / 23
DIAZINON	ND(0.5)	UG/L	CJB	132 / 23
PARATHION, METHYL	3.8	UG/L	CJB	132 / 23
PARATHION, ETHYL	ND(0.5)	UG/L	CJB	132 / 23
TRITHION	NOT ANAL.	UG/L	CJB	132 / 21
PHOSDRIN (MEVINPHOS)	ND(2.0)	UG/L	CJB	132 / 23
--CONCLUSION--LAB NUMBER: 8102-0781B				
LAB NUMBER: 8102-0781C SAMPLE DESCRIPTION: OWC-5 SPECIAL INSTRUCTIONS: FILTERED IN-FIELD				
ARSENIC	0.003	MG/L	BTF	131 / 54
CADMIUM	0.0010	MG/L	BTF	131 / 57
COPPER	0.012	MG/L	BTF	131 / 56
ZINC	0.07	MG/L	BTF	131 / 53
--CONCLUSION--LAB NUMBER: 8102-0781C				

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-4
CHEMICAL ANALYSES

Observation Well: OWC - 5

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-27-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-25-81

Time Sampled: 14:00

STANDARD CHEMICAL WATER ANALYSIS

DATE: 13 MARCH 1981

LABORATORY FILE NO.: 81-9521
LABORATORY NO.: 8102-0781A
SAMPLE RECEIVED 27 FEBRUARY 1981

			LABORATORY ANALYSIS
CATIONS			
CALCIUM	CA+2	MG/L	134.00
IRON	FE+2	MG/L	0.12
MAGNESIUM	MG+2	MG/L	36.70
MANGANESE	MN+2	MG/L	4.50
POTASSIUM	K +1	MG/L	2.20
SODIUM	NA+1	MG/L	82.00
ANIONS			
BICARBONATE	HCO3-1	MG/L	426.82
CARBONATE	CO3 -2	MG/L	0.11
CHLORIDE	CL -1	MG/L	46.00
FLUORIDE	F -1	MG/L	0.14
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	0.00
PHOSPHATE	PO4 -3	MG/L	0.92
SULFATE	SO4 -2	MG/L	95.00
SILICATE	SIO4-4	MG/L	0.02

SILICA		SIO2	MG/L	38.52
TOTAL FREE CARBON DIOXIDE		CO2	MG/L	605.20
EQUILIBRIUM CARBON DIOXIDE		CO2	MG/L	122.72
TOTAL DISSOLVED SOLIDS (CALC)			MG/L	860.05
TOTAL ALKALINITY	AS	CACO3	MG/L	349.94
CALCIUM ALKALINITY	AS	CACO3	MG/L	335.00
MAGNESIUM ALKALINITY	AS	CACO3	MG/L	14.94
SODIUM ALKALINITY	AS	CACO3	MG/L	0.00
TOTAL HARDNESS	AS	CACO3	MG/L	485.28
CALCIUM HARDNESS	AS	CACO3	MG/L	335.00
MAGNESIUM HARDNESS	AS	CACO3	MG/L	150.84
NON-CARBONATE HARDNESS	AS	CACO3	MG/L	135.33
CALCIUM NON-CARBONATE HARDNESS			MG/L	0.00
MAGNESIUM NON-CARBONATE HARDNESS			MG/L	135.89
PH	PH	UNITS		6.40
EQUILIBRIUM PH (PCO2)	PH	UNITS		6.92
STABILITY INDEX	PH	UNITS		7.43
SATURATION INDEX	PH	UNITS		0.52
TEMPERATURE DEGREES	FAHRENHEIT			68.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM			1450.00
IONIC STRENGTH (MOLAR)				0.0179
ION BALANCE ERROR (PERCENT) ACTIVITY CORRECTED				4.61

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-5
CHEMICAL ANALYSES

Observation Well: OWC - 6

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-26-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-24-81

Time Sampled: 15:10

ANALYSIS	CONCENTRATION	UNITS	ANALYST	BOOK/PAGE
LAB NUMBER: 8102-0700A SAMPLE DESCRIPTION: OWC-6 CHEVRON SPECIAL INSTRUCTIONS: FILTER GLASS FIBER				
DATE SAMPLED	2/24/81			/
TIME SAMPLED	15:10			/
ALDRIN	6.94	UG/L	CJB	132 / 21
CHLORDANE	ND(1.0)	UG/L	CJB	132 / 21
4,4-DDD	2.53	UG/L	CJB	132 / 21
4,4-DDE	ND(0.20)	UG/L	CJB	132 / 21
4,4-DDT	0.96	UG/L	CJB	132 / 21
DIELDRIN	3.89	UG/L	CJB	132 / 21
ENDRIN	ND(0.40)	UG/L	BKS	132 / 21
HEPTACHLOR	4.52	UG/L	CJB	132 / 21
MALATHION	ND(2.0)	UG/L	CJB	132 / 23
SEVIN	NOT ANAL.	UG/L	CJB	132 / 21
2,4,5-T	ND(0.1)	UG/L	CJB	132 / 22
TOXAPHENE	ND(10.0)	UG/L	CJB	132 / 21
PCB	1600	UG/L	CJB	132 / 21
LINDANE	43.2	UG/L	CJB	132 / 21
METHOXYCHLOR	ND(0.8)	UG/L	CJB	132 / 21
2,4-D	1.1	UG/L	CJB	132 / 21
MIREX	ND(0.5)	UG/L	CJB	132 / 21
CAPTAN	ND(0.20)	UG/L	CJB	132 / 21
DIFOLATAN	ND(20)	UG/L	CJB	132 / 21
CHLOROBENZILATE	ND(0.30)	UG/L	CJB	132 / 21
GUTHION	ND(100)	UG/L	CJB	132 / 23
DIAZINON	27.3	UG/L	CJB	132 / 23
PARATHION, METHYL	2.2	UG/L	CJB	132 / 23
PARATHION, ETHYL	0.8	UG/L	CJB	132 / 23
TRITHION	NOT ANAL.	UG/L	CJB	132 / 21
PHOSDRIN (MEVINPHOS)	2.3	UG/L	CJB	132 / 23
--CONCLUSION--LAB NUMBER: 8102-0700A				
LAB NUMBER: 8102-0700B SAMPLE DESCRIPTION: OWC-6 CHEVRON SPECIAL INSTRUCTIONS: FILTERED IN FIELD				
ARSENIC	0.056	MG/L	DTF	131 / 50
CADMIUM	0.0021	MG/L	RCR	130 / 196
COPPER	0.0018	MG/L	RCR	130 / 200
ZINC	0.039	MG/L	RCR	130 / 192
--CONCLUSION--LAB NUMBER: 8102-0700B				
LAB NUMBER: 8102-0700C SAMPLE DESCRIPTION: OWC-6 CHEVRON SPECIAL INSTRUCTIONS: NO PREP				
ALKALINITY, TOTAL	140	MG/L, AS CACO3	BLD	47 / 91
CALCIUM, BY EDTA TITRATION	107	MG/L	CJA	82 / 32
CHLORIDE	116	MG/L	BLD	108 / 35
FLUORIDE	0.195	MG/L	CJA	25 / 94
IRON, TOTAL	0.26	MG/L	RCR	130 / 186
MAGNESIUM	26	MG/L	RCR	130 / 190
MANGANESE	3.00	MG/L	RCR	130 / 186
NITRATE	0.9	MG/L AS N	CJA	109 / 32
ORTHOPHOSPHATE	0.05	MG/L AS P	BLD	128 / 9
PH	6.20		LKN	83 / 76
POTASSIUM	1.6	MG/L	RCR	130 / 188
SILICON	16	MG/L	RCR	130 / 190
SODIUM	33	MG/L	RCR	130 / 188
SPECIFIC CONDUCTANCE	1060	UMHOS/CM	MJB	124 / 10
SULFATE	145	MG/L	BLD	95 / 37
TOTAL ORGANIC CARBON	4.4	MG/L	GMD	85 / 69
--CONCLUSION--LAB NUMBER: 8102-0700C				

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-5
CHEMICAL ANALYSES

Observation Well: OWC - 6

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-26-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-24-81

Time Sampled: 15:10

STANDARD CHEMICAL WATER ANALYSIS

DATE: 13 MARCH 1981

LABORATORY FILE NO.: 81-9521
LABORATORY NO.: 8102-0700C
SAMPLE RECEIVED 26 FEBRUARY 1981

CATIONS			LABORATORY ANALYSIS
CALCIUM	CA+2	MG/L	107.00
IRON	FE+2	MG/L	0.26
MAGNESIUM	MG+2	MG/L	26.00
MANGANESE	MN+2	MG/L	3.00
POTASSIUM	K +1	MG/L	1.60
SODIUM	NA+1	MG/L	33.00
ANIONS			
BICARBONATE	HCO3-1	MG/L	170.76
CARBONATE	CO3 -2	MG/L	0.03
CHLORIDE	CL -1	MG/L	116.00
FLUORIDE	F -1	MG/L	0.19
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	3.99
PHOSPHATE	PO4 -3	MG/L	0.15
SULFATE	SO4 -2	MG/L	145.00
SILICATE	SIO4-4	MG/L	0.01
SILICA		SIO2 MG/L	34.24
TOTAL FREE CARBON DIOXIDE		CO2 MG/L	373.66
EQUILIBRIUM CARBON DIOXIDE		CO2 MG/L	16.18
TOTAL DISSOLVED SOLIDS (CALC)		MG/L	638.43
TOTAL ALKALINITY	AS	CACO3 MG/L	139.95
CALCIUM ALKALINITY	AS	CACO3 MG/L	139.95
MAGNESIUM ALKALINITY	AS	CACO3 MG/L	0.00
SODIUM ALKALINITY	AS	CACO3 MG/L	0.00
TOTAL HARDNESS	AS	CACO3 MG/L	373.90
CALCIUM HARDNESS	AS	CACO3 MG/L	267.50
MAGNESIUM HARDNESS	AS	CACO3 MG/L	106.86
NON-CARBONATE HARDNESS	AS	CACO3 MG/L	233.95
CALCIUM NON-CARBONATE HARDNESS		MG/L	127.55
MAGNESIUM NON-CARBONATE HARDNESS		MG/L	106.86
PH		PH UNITS	6.20
EQUILIBRIUM PH (PHS)		PH UNITS	7.40
STABILITY INDEX		PH UNITS	8.60
SATURATION INDEX		PH UNITS	-1.20
TEMPERATURE	DEGREES	FAHRENHEIT	68.00
CONDUCTIVITY, MEASURED		MICROMHOS/CM	1060.00
IONIC STRENGTH (MOLAR)			0.0144
ION BALANCE ERROR (PERCENT) BY CONCENTRATION			-0.53

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-6
CHEMICAL ANALYSES

Observation Well: OWC - 7

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-26-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-24-81

Time Sampled: 13:45

ANALYSIS	CONCENTRATION	UNITS	ANALYST	BOOK/PAGE
LAB NUMBER: 8102-0701A SAMPLE DESCRIPTION: OWC-7 CHEVRON SPECIAL INSTRUCTIONS: FILTER GLASS FIBER				
DATE SAMPLED	2/24/81			✓
TIME SAMPLED	13:45			✓
ALDRIN	63.3	UG/L	CJB	132 / 21
CHLORDANE	ND(1.0)	UG/L	CJB	132 / 21
4,4-DDD	ND(0.20)	UG/L	CJB	132 / 21
4,4-DDE	ND(0.20)	UG/L	CJB	132 / 21
4,4-DDT	ND(0.30)	UG/L	CJB	132 / 21
DIELDRIN	ND(0.20)	UG/L	CJB	132 / 21
ENDRIN	ND(0.40)	UG/L	BKS	132 / 21
HEPTACHLOR	ND(0.10)	UG/L	CJB	132 / 21
MALATHION	100	UG/L	CJB	132 / 23
SEVIN	NOT ANAL.	UG/L	CJB	132 / 21
2,4,5-T	0.2	UG/L	CJB	132 / 22
TOXAPHENE	ND(10.0)	UG/L	CJB	132 / 21
PCB	ND(10.0)	UG/L	CJB	132 / 21
LINDANE	1880	UG/L	CJB	132 / 21
METHOXYCHLOR	ND(0.8)	UG/L	CJB	132 / 21
2,4-D	2.6	UG/L	CJB	132 / 21
MIREX	ND(0.5)	UG/L	CJB	132 / 21
CAPTAN	ND(0.20)	UG/L	CJB	132 / 21
DIFOLATAN	ND(20)	UG/L	CJB	132 / 21
CHLOROBENZILATE	ND(0.30)	UG/L	CJB	132 / 21
GUTHION	ND(100)	UG/L	CJB	132 / 23
DIAZINON	427	UG/L	CJB	132 / 23
PARATHION, METHYL	6.1	UG/L	CJB	132 / 23
PARATHION, ETHYL	12.9	UG/L	CJB	132 / 23
TRITHION	NOT ANAL.	UG/L	CJB	132 / 21
PHOSDRIN (MEVINPHOS)	7.9	UG/L	CJB	132 / 23
--CONCLUSION--LAB NUMBER: 8102-0701A				
LAB NUMBER: 8102-0701B SAMPLE DESCRIPTION: OWC-7 CHEVRON SPECIAL INSTRUCTIONS: FILTERED IN FIELD				
ARSENIC	0.13	MG/L	BTF	131 / 50
CADMIUM	0.012	MG/L	RCR	130 / 194
COPPER	0.096	MG/L	RCR	130 / 198
ZINC	0.36	MG/L	RCR	130 / 192
--CONCLUSION--LAB NUMBER: 8102-0701B				
LAB NUMBER: 8102-0701C SAMPLE DESCRIPTION: OWC-7 CHEVRON SPECIAL INSTRUCTIONS: NO PREP				
ALKALINITY, TOTAL	320	MG/L, AS CACO3	BLD	47 / 91
CALCIUM, BY EDTA TITRATION	139	MG/L	CJA	82 / 32
CHLORIDE	296	MG/L	BLD	108 / 35
FLUORIDE	0.245	MG/L	CJA	25 / 94
IRON, TOTAL	0.69	MG/L	RCR	130 / 186
MAGNESIUM	58	MG/L	RCR	130 / 190
MANGANESE	14	MG/L	RCR	130 / 186
NITRATE	ND(0.1)	MG/L AS N	CJA	109 / 32
ORTHOPHOSPHATE	0.15	MG/L AS P	BLD	128 / 9
PH	6.30		LKN	83 / 78
POTASSIUM	5.5	MG/L	RCR	130 / 188
SILICON	11	MG/L	RCR	130 / 190
SODIUM	114	MG/L	RCR	130 / 188
SPECIFIC CONDUCTANCE	1060	UMHOS/CM	MJB	124 / 10
SULFATE	220	MG/L	BLD	95 / 37
TOTAL ORGANIC CARBON	93	MG/L	GMD	85 / 69
--CONCLUSION--LAB NUMBER: 8102-0701C				

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-6
CHEMICAL ANALYSES

Observation Well: OWC - 7

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-26-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-24-81

Time Sampled: 13:45

STANDARD CHEMICAL WATER ANALYSIS

DATE: 13 MARCH 1981

LABORATORY FILE NO.: 81-9521
LABORATORY NO.: 8102-0701C
SAMPLE RECEIVED 26 FEBRUARY 1981

CATIONS			LABORATORY ANALYSIS
CALCIUM	CA+2	MG/L	139.00
IRON	FE+2	MG/L	0.69
MAGNESIUM	MG+2	MG/L	58.00
MANGANESE	MN+2	MG/L	14.00
POTASSIUM	K +1	MG/L	5.50
SODIUM	NA+1	MG/L	114.00
ANIONS			
BICARBONATE	HCO3-1	MG/L	390.26
CARBONATE	CO3 -2	MG/L	0.10
CHLORIDE	CL -1	MG/L	296.00
FLUORIDE	F -1	MG/L	0.24
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	0.00
PHOSPHATE	PO4 -3	MG/L	0.46
SULFATE	SO4 -2	MG/L	220.00
SILICATE	SIO4-4	MG/L	0.01
SILICA		SIO2 MG/L	23.54
TOTAL FREE CARBON DIOXIDE		CO2 - MG/L	737.78
EQUILIBRIUM CARBON DIOXIDE		CO2 MG/L	99.91
TOTAL DISSOLVED SOLIDS (CALC)		MG/L	1255.41
TOTAL ALKALINITY	AS	CACO3 MG/L	319.96
CALCIUM ALKALINITY	AS	CACO3 MG/L	319.96
MAGNESIUM ALKALINITY	AS	CACO3 MG/L	0.00
SODIUM ALKALINITY	AS	CACO3 MG/L	0.00
TOTAL HARDNESS	AS	CACO3 MG/L	585.36
CALCIUM HARDNESS	AS	CACO3 MG/L	347.50
MAGNESIUM HARDNESS	AS	CACO3 MG/L	238.38
NON-CARBONATE HARDNESS	AS	CACO3 MG/L	265.40
CALCIUM NON CARBONATE HARDNESS		MG/L	27.54
MAGNESIUM NON CARBONATE HARDNESS		MG/L	238.38
PH	PH	UNITS	6.30
EQUILIBRIUM PH (PHS)	PH	UNITS	6.96
STABILITY INDEX	PH	UNITS	7.61
SATURATION INDEX	PH	UNITS	0.66
TEMPERATURE	DEGREES	FAHRENHEIT	60.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM		1030.00
IONIC STRENGTH (MOLAR)			0.0268
ION BALANCE ERROR (PERCENT) BY CONCENTRATION			-5.49

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-7
CHEMICAL ANALYSES

Observation Well: OWC - 8

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-26-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-24-81

Time Sampled: 13:10

ANALYSIS	CONCENTRATION	UNITS	ANALYST	BOOK/PAGE
LAB NUMBER: 8102-0702A	SAMPLE DESCRIPTION: OWC-8 CHEVRON			
	SPECIAL INSTRUCTIONS: FILTER GLASS FIBER			
DATE SAMPLED	2/24/81			/
TIME SAMPLED	13:10			/
ALDRIN	4.59	UG/L	CJB	132 / 21
CHLORDANE	ND(1.0)	UG/L	CJB	132 / 21
4,4-DDD	ND(0.20)	UG/L	CJB	132 / 21
4,4-DDE	ND(0.20)	UG/L	CJB	132 / 21
4,4-DDT	ND(0.30)	UG/L	CJB	132 / 23
DIELDRIN	1.45	UG/L	CJB	132 / 21
ENDRIN	ND(0.40)	UG/L	BKS	132 / 21
HEPTACHLOR	ND(0.10)	UG/L	CJB	132 / 21
MALATHION	ND(2.0)	UG/L	CJB	132 / 23
SEVIN	NOT ANAL.	UG/L	CJB	132 / 21
2,4,5-T	9.7	UG/L	CJB	132 / 22
TOXAPHENE	ND(10.0)	UG/L	CJB	132 / 21
PCB	ND(10.0)	UG/L	CJB	132 / 21
LINDANE	184	UG/L	CJB	132 / 21
METHOXYCHLOR	ND(0.8)	UG/L	CJB	132 / 21
2,4-D	87.6	UG/L	CJB	132 / 21
MIREX	ND(0.5)	UG/L	CJB	132 / 21
CAPTAN	ND(0.20)	UG/L	CJB	132 / 21
DIFOLATAN	ND(20)	UG/L	CJB	132 / 21
CHLOROBENZILATE	ND(0.30)	UG/L	CJB	132 / 23
GUTHION	ND(100)	UG/L	CJB	132 / 23
DIAZINON	37.8	UG/L	CJB	132 / 23
PARATHION, METHYL	1.6	UG/L	CJB	132 / 23
PARATHION, ETHYL	2.5	UG/L	CJB	132 / 23
TRITHION	NOT ANAL.	UG/L	CJB	132 / 21
PHOSDRIN (MEVINPHOS)	ND(2.0)	UG/L	CJB	132 / 23
--CONCLUSION--LAB NUMBER: 8102-0702A				
LAB NUMBER: 8102-0702B	SAMPLE DESCRIPTION: OWC-8 CHEVRON			
	SPECIAL INSTRUCTIONS: FILTERED IN FIELD			
ARSENIC	0.005	MG/L	BTF	131 / 51
CADMIUM	0.0010	MG/L	RCR	130 / 196
COPPER	0.0028	MG/L	RCR	130 / 200
ZINC	0.059	MG/L	RCR	130 / 192
--CONCLUSION--LAB NUMBER: 8102-0702B				
LAB NUMBER: 8102-0702C	SAMPLE DESCRIPTION: OWC-8 CHEVRON			
	SPECIAL INSTRUCTIONS: NO PREP			
ALKALINITY, TOTAL	360	MG/L, AS CACO3	BLD	47 / 91
CALCIUM, BY EDTA TITRATION	146	MG/L	CJA	82 / 32
CHLORIDE	120	MG/L	BLD	108 / 35
FLUORIDE	0.21	MG/L	CJA	25 / 94
IRON, TOTAL	0.21	MG/L	RCR	130 / 186
MAGNESIUM	26	MG/L	RCR	130 / 190
MANGANESE	0.18	MG/L	RCR	130 / 186
NITRATE	0.2	MG/L AS N	CJA	109 / 32
ORTHOPHOSPHATE	ND(0.05)	MG/L AS P	BLD	128 / 9
PH	6.60		LKN	83 / 76
POTASSIUM	3.0	MG/L	RCR	130 / 188
SILICON	14	MG/L	RCR	130 / 190
SODIUM	54	MG/L	RCR	130 / 188
SPECIFIC CONDUCTANCE	1350	UMHOS/CM	MJB	124 / 10
SULFATE	95	MG/L	BLD	95 / 37
TOTAL ORGANIC CARBON	7.5	MG/L	GMD	85 / 69
--CONCLUSION--LAB NUMBER: 8102-0702C				

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-7
CHEMICAL ANALYSES

Observation Well: OWC - 8

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-26-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-24-81

Time Sampled: 13:10

STANDARD CHEMICAL WATER ANALYSIS

DATE: 13 MARCH 1981

LABORATORY FILE NO.: 81-9521
LABORATORY NO.: 8102-0702C
SAMPLE RECEIVED 26 FEBRUARY 1981

			LABORATORY ANALYSIS
CATIONS			
CALCIUM	CA+2	MG/L	146.00
IRON	FE+2	MG/L	0.21
MAGNESIUM	MG+2	MG/L	26.00
MANGANESE	MN+2	MG/L	0.18
POTASSIUM	K +1	MG/L	3.00
SODIUM	NA+1	MG/L	54.00
ANIONS			
BICARBONATE	HCO3-1	MG/L	438.87
CARBONATE	CO3 -2	MG/L	0.18
CHLORIDE	CL -1	MG/L	120.00
FLUORIDE	F -1	MG/L	0.21
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	0.89
PHOSPHATE	PO4 -3	MG/L	0.00
SULFATE	SO4 -2	MG/L	95.00
SILICATE	SIO4-4	MG/L	0.03
SILICA		SIO2 MG/L	29.96
TOTAL FREE CARBON DIOXIDE		CO2 MG/L	392.90
EQUILIBRIUM CARBON DIOXIDE		CO2 MG/L	141.34
TOTAL DISSOLVED SOLIDS (CALC)			MG/L 907.33
TOTAL ALKALINITY	AS	CACO3	MG/L 359.94
CALCIUM ALKALINITY	AS	CACO3	MG/L 359.94
MAGNESIUM ALKALINITY	AS	CACO3	MG/L 0.00
SODIUM ALKALINITY	AS	CACO3	MG/L 0.00
TOTAL HARDNESS	AS	CACO3	MG/L 471.21
CALCIUM HARDNESS	AS	CACO3	MG/L 365.00
MAGNESIUM HARDNESS	AS	CACO3	MG/L 106.86
NON-CARBONATE HARDNESS	AS	CACO3	MG/L 111.27
CALCIUM NON-CARBONATE HARDNESS			MG/L 5.06
MAGNESIUM NON-CARBONATE HARDNESS			MG/L 106.86
PH		PH UNITS	6.60
EQUILIBRIUM PH (PHS)		PH UNITS	6.87
STABILITY INDEX		PH UNITS	7.13
SATURATION INDEX		PH UNITS	0.27
TEMPERATURE	DEGREES	FAHRENHEIT	68.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM		1350.00
IONIC STRENGTH (MOLAR)			0.0179
ION BALANCE ERROR (PERCENT) BY CONCENTRATION			2.96

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-8
CHEMICAL ANALYSES

Observation Well: OWC - 9

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-27-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-26-81

Time Sampled: 10:10

ANALYSIS	CONCENTRATION	UNITS	ANALYST	BOOK/PAGE
LAB NUMBER: 8102-0782A SAMPLE DESCRIPTION: OWC-9 SPECIAL INSTRUCTIONS: NO PREP				
DATE SAMPLED	2/26/81			/
TIME SAMPLED	1045			/
ALKALINITY, TOTAL		MG/L, AS CACO3	/	
CALCIUM, BY EDTA TITRATION	72	MG/L	CJA	82 / 32
CHLORIDE	7	MG/L	BLD	108 / 35
FLUORIDE	0.52	MG/L	CJA	25 / 94
IRON, TOTAL		MG/L	/	
MAGNESIUM		MG/L	/	
MANGANESE		MG/L	/	
NITRATE	1.4	MG/L AS N	CJA	109 / 32
ORTHOPHOSPHATE	ND(0.05)	MG/L AS P	BLD	128 / 9
PH	6.95		LKN	83 / 78
POTASSIUM		MG/L	/	
SILICON		MG/L	/	
SODIUM		MG/L	/	
SPECIFIC CONDUCTANCE	691	UMHOS/CM	MJD	124 / 11
SULFATE		MG/L	/	
TOTAL ORGANIC CARBON	2.2	MG/L	GMB	85 / 69
--CONCLUSION--LAB NUMBER: 8102-0782A				
LAB NUMBER: 8102-0782B SAMPLE DESCRIPTION: OWC-9 SPECIAL INSTRUCTIONS: FILTER-GLASS-FIBER				
ALDRIN	0.26	UG/L	CJB	132 / 21
CHLORDANE	ND(1.0)	UG/L	CJB	132 / 21
4,4-DDD	1.08	UG/L	CJB	132 / 21
4,4-DDE	0.22	UG/L	CJB	132 / 21
4,4-DDT	0.53	UG/L	CJB	132 / 21
DIELDRIN	0.55	UG/L	CJB	132 / 21
ENDRIN	ND(0.40)	UG/L	BKS	132 / 21
HEPTACHLOR	ND(0.10)	UG/L	CJB	132 / 21
MALATHION	ND(2.0)	UG/L	CJB	132 / 23
SEVIN	NOT ANAL.	UG/L	CJB	132 / 21
2,4,5-T	ND(0.1)	UG/L	CJB	132 / 22
TOXAPHENE	ND(10.0)	UG/L	CJB	132 / 21
PCB	ND(10.0)	UG/L	CJB	132 / 21
LINDANE	0.82	UG/L	CJB	132 / 21
METHOXYCHLOR	ND(0.8)	UG/L	CJB	132 / 21
2,4-D	ND(1.0)	UG/L	CJB	132 / 21
MIREX	ND(0.5)	UG/L	CJB	132 / 21
CAPTAN	ND(0.20)	UG/L	CJB	132 / 21
DIFOLATAN	ND(20)	UG/L	CJB	132 / 21
CHLOROBENZILATE	ND(0.30)	UG/L	CJB	132 / 21
GUTHION	ND(100)	UG/L	CJB	132 / 23
DIAZINON	ND(0.5)	UG/L	CJB	132 / 23
PARATHION, METHYL	ND(2.0)	UG/L	CJB	132 / 23
PARATHION, ETHYL	ND(0.5)	UG/L	CJB	132 / 23
TRITHION	NOT ANAL.	UG/L	CJB	132 / 21
PHOSDRIN (MEVINPHOS)	ND(2.0)	UG/L	CJB	132 / 23
--CONCLUSION--LAB NUMBER: 8102-0782B				
LAB NUMIER: 8102-0782C SAMPLE DESCRIPTION: OWC-9 SPECIAL INSTRUCTIONS: FILTERED IN FIELD				
ARSENIC	0.005	MG/L	BTF	131 / 54
CADMIUM	ND(0.0005)	MG/L	BTF	131 / 57
COPPER	0.0015	MG/L	BTF	131 / 56
ZINC	0.04	MG/L	BTF	131 / 53
--CONCLUSION--LAB NUMBER: 8102-0782C				

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-8
CHEMICAL ANALYSES

Observation Well: OWC - 9

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-27-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-26-81

Time Sampled: 10:10

STANDARD CHEMICAL WATER ANALYSIS

DATE: 03/13/81

LABORATORY FILE NO.: 81-9521
LABORATORY NO.: 8102-0782A
SAMPLE RECEIVED 02/27/81

			LABORATORY ANALYSIS
CATIONS			
CALCIUM	CA+2	MG/L	72.00
IRON	FE+2	MG/L	0.00
MAGNESIUM	MG+2	MG/L	20.90
MANGANESE	MN+2	MG/L	0.58
POTASSIUM	K +1	MG/L	1.10
SODIUM	NA+1	MG/L	35.00
ANIONS			
BICARBONATE	HCO3-1	MG/L	365.46
CARBONATE	CO3 -2	MG/L	0.27
CHLORIDE	CL -1	MG/L	7.00
FLUORIDE	F -1	MG/L	0.52
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	6.20
PHOSPHATE	PO4 -3	MG/L	0.00
SULFATE	SO4 -2	MG/L	35.00
SILICATE	SIO4-4	MG/L	0.03
SILICA	SIO2	MG/L	12.84
TOTAL FREE CARBON DIOXIDE	CO2	MG/L	136.65
EQUILIBRIUM CARBON DIOXIDE	CO2	MG/L	52.86
TOTAL DISSOLVED SOLIDS (CALC)		MG/L	550.92
TOTAL ALKALINITY	AS CACO3	MG/L	299.95
CALCIUM ALKALINITY	AS CACO3	MG/L	180.00
MAGNESIUM ALKALINITY	AS CACO3	MG/L	85.90
SODIUM ALKALINITY	AS CACO3	MG/L	34.35
TOTAL HARDNESS	AS CACO3	MG/L	265.60
CALCIUM HARDNESS	AS CACO3	MG/L	180.00
MAGNESIUM HARDNESS	AS CACO3	MG/L	85.90
NON-CARBONATE HARDNESS	AS CACO3	MG/L	0.00
CALCIUM NON-CARBONATE HARDNESS		MG/L	0.00
MAGNESIUM NON CARBONATE HARDNESS		MG/L	0.00
PH	PH UNITS		6.95
EQUILIBRIUM PH (PHS)	PH UNITS		7.23
STABILITY INDEX	PH UNITS		7.50
SATURATION INDEX	PH UNITS		-0.28
TEMPERATURE	DEGREES FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM		691.00
IONIC STRENGTH (MOLAR)			0.0100
ION BALANCE ERROR (PERCENT) BY CONCENTRATION			-1.21

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-12
CHEMICAL ANALYSES

Observation Well: OWC - 13

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-27-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-25-81

Time Sampled: 13:00

STANDARD CHEMICAL WATER ANALYSIS--

DATE: 03/12/81

LABORATORY FILE NO.: 81-9521
LABORATORY NO.: 8102-0784B
SAMPLE RECEIVED 02/27/81

			LABORATORY ANALYSIS
CATIONS			
CALCIUM	CA+2	MG/L	232.00
IRON	FE+2	MG/L	0.00
MAGNESIUM	MG+2	MG/L	42.90
MANGANESE	MN+2	MG/L	1.30
POTASSIUM	K +1	MG/L	1.20
SODIUM	NA+1	MG/L	52.00
ANIONS			
BICARBONATE	HCO3-1	MG/L	219.50
CARBONATE	CO3 -2	MG/L	0.06
CHLORIDE	CL -1	MG/L	232.00
FLUORIDE	F -1	MG/L	0.14
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	0.00
PHOSPHATE	PO4 -3	MG/L	0.00
SULFATE	SO4 -2	MG/L	200.00
SILICATE	SIO4-4	MG/L	0.01

SILICA		SIO2	MG/L	23.54
TOTAL FREE CARBON DIOXIDE		CO2	MG/L	367.19
EQUILIBRIUM CARBON DIOXIDE		CO2	MG/L	53.14
TOTAL DISSOLVED SOLIDS (CALC)			MG/L	1001.06
TOTAL ALKALINITY	AS	CACO3	MG/L	179.96
CALCIUM ALKALINITY	AS	CACO3	MG/L	179.96
MAGNESIUM ALKALINITY	AS	CACO3	MG/L	0.00
SODIUM ALKALINITY	AS	CACO3	MG/L	0.00
TOTAL HARDNESS	AS	CACO3	MG/L	755.29
CALCIUM HARDNESS	AS	CACO3	MG/L	580.00
MAGNESIUM HARDNESS	AS	CACO3	MG/L	176.32
NON-CARBONATE HARDNESS	AS	CACO3	MG/L	575.33
CALCIUM NON-CARBONATE HARDNESS			MG/L	400.04
MAGNESIUM NON-CARBONATE HARDNESS			MG/L	176.32
PH		PH	UNITS	6.35
EQUILIBRIUM PH (PHS)		PH	UNITS	6.98
STABILITY INDEX		PH	UNITS	7.61
SATURATION INDEX		PH	UNITS	-0.63
TEMPERATURE	DEGREES	FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM			1560.00
IONIC STRENGTH (MOLAR)				0.0255
ION BALANCE ERROR (PERCENT) ACTIVITY CORRECTED				-1.28

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-13
CHEMICAL ANALYSES

Observation Well: OWC - 14

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-27-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-25-81

Time Sampled: 15:30

ANALYSIS	CONCENTRATION	UNITS	ANALYST	BOOK/PAGE
LAB NUMBER: 8102-0785A SAMPLE DESCRIPTION: OWC-14 SPECIAL INSTRUCTIONS: NO PREP				
DATE SAMPLED	2/25/81			/
TIME SAMPLED	1530			/
ALKALINITY, TOTAL		MG/L, AS CACO3		/
CALCIUM, BY EDTA TITRATION	104	MG/L	CJA	82 / 32
CHLORIDE	74	MG/L	RLD	108 / 35
FLUORIDE	0.165	MG/L	CJA	25 / 94
IRON, TOTAL		MG/L		/
MAGNESIUM		MG/L		/
MANGANESE		MG/L		/
NITRATE	1.0	MG/L AS N	CJA	109 / 32
ORTHOPHOSPHATE	0.10	MG/L AS P	BLD	128 / 9
PH	6.85		LKN	63 / 78
POTASSIUM		MG/L		/
SILICON		MG/L		/
SODIUM		MG/L		/
SPECIFIC CONDUCTANCE	1050	UMHOS/CM	MJB	124 / 11
SULFATE		MG/L		/
TOTAL ORGANIC CARBON	5.6	MG/L	GMD	85 / 69
--CONCLUSION--LAB NUMBER: 8102-0785A				
LAB NUMBER: 8102-0785B SAMPLE DESCRIPTION: OWC-14 SPECIAL INSTRUCTIONS: FILTER GLASS FIBER				
ALDRIN	0.88	UG/L	CJB	132 / 21
CHLORDANE	ND(1.0)	UG/L	CJB	132 / 21
4,4-DDD	.50	UG/L	CJB	132 / 21
4,4-DDE	ND(0.20)	UG/L	CJB	132 / 21
4,4-DDT	ND(0.30)	UG/L	CJB	132 / 21
DIELDRIN	0.69	UG/L	CJB	132 / 21
ENDRIN	ND(0.40)	UG/L	RKS	132 / 21
HEPTACHLOR	ND(0.10)	UG/L	CJB	132 / 21
MALATHION	ND(2.0)	UG/L	CJB	132 / 23
SEVIN	NOT ANAL.	UG/L	CJB	132 / 21
2,4,5-T	ND(0.1)	UG/L	CJB	132 / 22
TOXAPHENE	ND(10.0)	UG/L	CJB	132 / 21
PCB	ND(10.0)	UG/L	CJB	132 / 21
LINDANE	0.93	UG/L	CJB	132 / 21
METHOXYCHLOR	ND(0.8)	UG/L	CJB	132 / 21
2,4-D	ND(1.0)	UG/L	CJB	132 / 21
MIREX	ND(0.5)	UG/L	CJB	132 / 21
CAPTAN	ND(0.20)	UG/L	CJB	132 / 21
DIFOLATAN	ND(20)	UG/L	CJB	132 / 21
CHLOROBENZILATE	ND(0.30)	UG/L	CJB	132 / 21
GUTHION	ND(100)	UG/L	CJB	132 / 23
DIAZINON	ND(0.5)	UG/L	CJB	132 / 23
PARATHION, METHYL	ND(2.0)	UG/L	CJB	132 / 23
PARATHION, ETHYL	ND(0.5)	UG/L	CJB	132 / 23
TRITHION	NOT ANAL.	UG/L	CJB	132 / 21
PHOSDRIN (MEVINPHOS)	ND(2.0)	UG/L	CJB	132 / 23
--CONCLUSION--LAB NUMBER: 8102-0785B				
LAB NUMBER: 8102-0785C SAMPLE DESCRIPTION: OWC-14 SPECIAL INSTRUCTIONS: FILTERED IN FIELD				
ARSENIC	0.008	MG/L	BTF	131 / 54
CADMIUM	0.0018	MG/L	BTF	131 / 57
COPPER	0.020	MG/L	BTF	131 / 56
ZINC	0.08	MG/L	BTF	131 / 53
--CONCLUSION--LAB NUMBER: 8102-0785C				

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-13
CHEMICAL ANALYSES

Observation Well: OWC - 14

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-27-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-25-81

Time Sampled: 15:30

STANDARD CHEMICAL WATER ANALYSIS

DATE: 03/13/81

LABORATORY FILE NO.: 81-9521
LABORATORY NO.: 8102-0785A
SAMPLE RECEIVED 02/27/81

			LABORATORY ANALYSIS
CATIONS			
CALCIUM	CA+2	MG/L	104.00
IRON	FE+2	MG/L	0.08
MAGNESIUM	MG+2	MG/L	25.10
MANGANESE	MN+2	MG/L	0.00
POTASSIUM	K +1	MG/L	2.10
SODIUM	NA+1	MG/L	58.00
ANIONS			
BICARBONATE	HCO3-1	MG/L	365.48
CARBONATE	CO3 -2	MG/L	0.25
CHLORIDE	CL -1	MG/L	74.00
FLUORIDE	F- -1	MG/L	0.17
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	4.43
PHOSPHATE	PO4 -3	MG/L	0.31
SULFATE	SO4 -2	MG/L	100.00
SILICATE	SIO4-4	MG/L	0.04
SILICA		SIO2 MG/L	27.82
TOTAL FREE CARBON DIOXIDE		CO2 MG/L	179.56
EQUILIBRIUM CARBON DIOXIDE		CO2 MG/L	72.00
TOTAL DISSOLVED SOLIDS (CALC)		MG/L	755.78
TOTAL ALKALINITY	AS	CACO3 MG/L	299.92
CALCIUM ALKALINITY	AS	CACO3 MG/L	260.00
MAGNESIUM ALKALINITY	AS	CACO3 MG/L	39.92
SODIUM ALKALINITY	AS	CACO3 MG/L	0.00
TOTAL HARDNESS	AS	CACO3 MG/L	362.72
CALCIUM HARDNESS	AS	CACO3 MG/L	260.00
MAGNESIUM HARDNESS	AS	CACO3 MG/L	103.16
NON-CARBONATE HARDNESS	AS	CACO3 MG/L	62.80
CALCIUM NON-CARBONATE HARDNESS		MG/L	0.00
MAGNESIUM NON-CARBONATE HARDNESS		MG/L	63.24
PH	PH	UNITS	6.85
EQUILIBRIUM PH (PHS)	PH	UNITS	7.08
STABILITY INDEX	PH	UNITS	7.32
SATURATION INDEX	PH	UNITS	-0.23
TEMPERATURE	DEGREES	FAHRENHEIT	68.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM		1050.00
IONIC STRENGTH (MOLAR)			0.0147
ION BALANCE ERROR (PERCENT) BY CONCENTRATION			-2.11

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-14
CHEMICAL ANALYSES

Observation Well: OWC - 15

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-27-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-25-81

Time Sampled: 14:45

ANALYSIS	CONCENTRATION	UNITS	ANALYST	BOOK/PAGE
LAB NUMBER: 8102-0786A SAMPLE DESCRIPTION: OWC-15 SPECIAL INSTRUCTIONS: NO PREP				
DATE SAMPLED	2/25/81			/
TIME SAMPLED	1445			/
ALKALINITY, TOTAL		MG/L, AS CACO3	/	
CALCIUM, BY EDTA TITRATION	39	MG/L	CJA	82 / 32
CHLORIDE	28.5	MG/L	BLD	108 / 35
FLUORIDE	0.145	MG/L	CJA	25 / 94
IRON, TOTAL		MG/L	/	
MAGNESIUM		MG/L	/	
MANGANESE		MG/L	/	
NITRATE	1.9	MG/L AS N	CJA	109 / 32
ORTHOPHOSPHATE	0.07	MG/L AS P	BLD	128 / 9
PH	6.60		LKN	83 / 78
POTASSIUM		MG/L	/	
SILICON		MG/L	/	
SODIUM		MG/L	/	
SPECIFIC CONDUCTANCE	411	UMHOS/CM	MJB	124 / 11
SULFATE		MG/L	/	
TOTAL ORGANIC CARBON	1.9	MG/L	GMD	85 / 69
--CONCLUSION--LAB NUMBER: 8102-0786A				
LAB NUMBER: 8102-0786B SAMPLE DESCRIPTION: OWC-15 SPECIAL INSTRUCTIONS: FILTER GLASS FIBER				
ALDRIN	ND(0.12)	UG/L	CJB	132 / 21
CHLORDANE	ND(1.0)	UG/L	CJB	132 / 21
4,4-DDD	ND(0.20)	UG/L	CJB	132 / 21
4,4-DDE	ND(0.20)	UG/L	CJB	132 / 21
4,4-DDT	ND(0.30)	UG/L	CJB	132 / 21
DIELDRIN	0.21	UG/L	CJB	132 / 21
ENDRIN	ND(0.40)	UG/L	BKS	132 / 21
HEPTACHLOR	ND(0.10)	UG/L	CJB	132 / 21
MALATHION	ND(2.0)	UG/L	CJB	132 / 23
SEVIN	NOT ANAL.	UG/L	CJB	132 / 21
2,4,5-T	ND(0.1)	UG/L	CJB	132 / 22
TOXAPHENE	ND(10.0)	UG/L	CJB	132 / 21
PCB	ND(10.0)	UG/L	CJB	132 / 21
LINDANE	0.23	UG/L	CJB	132 / 21
METHOXYCHLOR	ND(0.8)	UG/L	CJB	132 / 21
2,4-D	ND(1.0)	UG/L	CJB	132 / 21
MIREX	ND(0.5)	UG/L	CJB	132 / 21
CAPTAN	ND(0.20)	UG/L	CJB	132 / 21
DIFOLATAN	ND(20)	UG/L	CJB	132 / 21
CHLOROBENZILATE	ND(0.30)	UG/L	CJB	132 / 21
GUTHION	ND(100)	UG/L	CJB	132 / 23
DIAZINON	ND(0.5)	UG/L	CJB	132 / 23
PARATHION, METHYL	ND(2.0)	UG/L	CJB	132 / 23
PARATHION, ETHYL	ND(0.5)	UG/L	CJB	132 / 23
TRITHION	NOT ANAL.	UG/L	CJB	132 / 21
PHOSDRIN (MEVINPHOS)	ND(2.0)	UG/L	CJB	132 / 23
--CONCLUSION--LAB NUMBER: 8102-0786B				
LAB NUMBER: 8102-0786C SAMPLE DESCRIPTION: OWC-15 SPECIAL INSTRUCTIONS: FILTERED IN FIELD				
ARSENIC	ND(0.001)	MG/L	BTF	131 / 54
CADMIUM	ND(0.0005)	MG/L	BTF	131 / 57
COPPER	0.0020	MG/L	BTF	131 / 56
ZINC	0.03	MG/L	BTF	131 / 53
--CONCLUSION--LAB NUMBER: 8102-0786C				

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-14
CHEMICAL ANALYSES

Observation Well: OWC - 15

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-27-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-25-81

Time Sampled: 14:45

STANDARD CHEMICAL WATER ANALYSIS

DATE: 03/12/81

LABORATORY FILE NO.: 81-9521
LABORATORY NO.: 8102-0786A
SAMPLE RECEIVED 02/27/81

			LABORATORY ANALYSIS
CATIONS			
CALCIUM	CA+2	MG/L	39.00
IRON	FE+2	MG/L	0.09
MAGNESIUM	MG+2	MG/L	12.40
MANGANESE	MN+2	MG/L	0.07
POTASSIUM	K +1	MG/L	0.70
SODIUM	NA+1	MG/L	12.00
ANIONS			
BICARBONATE	HCO3-1	MG/L	79.21
CARBONATE	CO3 -2	MG/L	0.02
CHLORIDE	CL -1	MG/L	28.50
FLUORIDE	F -1	MG/L	0.14
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	8.42
PHOSPHATE	PO4 -3	MG/L	0.21
SULFATE	SO4 -2	MG/L	60.00
SILICATE	SIO4-4	MG/L	0.03

SILICA		SIO2	MG/L	34.24
TOTAL FREE CARBON DIOXIDE		CO2	MG/L	62.94
EQUILIBRIUM CARBON DIOXIDE		CO2	MG/L	1.44
TOTAL DISSOLVED SOLIDS (CALC)			MG/L	273.74
TOTAL ALKALINITY	AS	CACO3	MG/L	64.94
CALCIUM ALKALINITY	AS	CACO3	MG/L	64.94
MAGNESIUM ALKALINITY	AS	CACO3	MG/L	0.00
SODIUM ALKALINITY	AS	CACO3	MG/L	0.00
TOTAL HARDNESS	AS	CACO3	MG/L	148.31
CALCIUM HARDNESS	AS	CACO3	MG/L	97.50
MAGNESIUM HARDNESS	AS	CACO3	MG/L	50.96
NON-CARBONATE HARDNESS	AS	CACO3	MG/L	83.37
CALCIUM NON-CARBONATE HARDNESS			MG/L	32.56
MAGNESIUM NON-CARBONATE HARDNESS			MG/L	50.96
PH	PH	UNITS		6.60
EQUILIBRIUM PH (PHS)	PH	UNITS		8.13
STABILITY INDEX	PH	UNITS		9.66
SATURATION INDEX	PH	UNITS		-1.53
TEMPERATURE	DEGREES	FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM			411.00
IONIC STRENGTH (MOLAR)				0.0056
ION BALANCE ERROR (PERCENT) BY CONCENTRATION				0.13

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

APPENDIX G

DISCUSSION OF LABORATORY ANALYSES AND METHODOLOGY

WILSON LABORATORIES
ANALYTICAL & RESEARCH CHEMISTS & BIOLOGISTS
A DIVISION OF WILSON & COMPANY, ENGINEERS & ARCHITECTS

528 NORTH NINTH • SALINA, KANSAS 67401 • LAB: (913) 825-7186 OFFICE: (913) 827-0433

13 March 1981

Dr. J. D. Campbell
Woodward-Clyde Consultants
5055 Antioch Road
Overland Park, KS 66203

Re: Wilson Laboratories File No. 81-9521

Dear Dr. Campbell:

Enclosed are the results of the analyses of the Chevron soil and water samples. The organic analyses were performed in accordance with EPA procedures published in the Federal Register, Volume 38, No. 75, Pt. II.; all other analyses were performed in accordance with EPA procedures published in the Federal Register, Volume 44, No. 233, Monday, 23 December 1979, pages 69568 through 69573. Samples for heavy metals analyses were filtered in the field through a 0.45 micron filter. Samples for organic analyses were filtered through a glass fiber filter of approximately 1 micron pore size prior to analyses.

Analyses for Kelthane, Sevin and Trithion have not been performed.

Kelthane did not elute properly from the gas chromatograph and could not be analyzed in the samples.

It was anticipated that Sevin could be analyzed with the organophosphorus pesticides on the nitrogen/phosphorus gas chromatograph detector. However, analyses of the samples indicated that interferences were present, which precluded use of the nitrogen/phosphorus detector for the organophosphorus compounds. The samples were then analyzed with the highly selective flame photometric detector operated in the phosphorus mode. Using this mode of operation, six phosphorus containing compounds were analyzed but Sevin could not be detected because the detector is not sensitive to nitrogen containing compounds.

A standard has been ordered for Trithion but has not been received. The extracts can be re-analyzed for Trithion upon receipt of the standard, however, no unidentified peaks were observed in the analyses of the organophosphorus pesticides indicating that Trithion was not present.

Lindane and Aldrin results on sample OWC-13 were confirmed by analyses of the extract by capillary gas chromatography with Hall electrolytic conductivity detection operated in the halogen mode.

- continued -

The most frequently observed pesticide was Lindane, the gamma isomer of hexachlorocyclohexane. In samples OWC-7 and OWC-13 the concentration was approximately 2 mg/1. The Handbook of Environmental Data on Organic Chemicals by Karl Verschaeren published by Van Nostrand and Reinholt in 1977 states that the water solubility of Lindane is 10 mg/1.

The drinking water limits for parameters of interest are tabulated below:

Arsenic	0.05 mg/1
Cadmium	0.010 mg/1
Copper	1.0 mg/1 (Secondary Standard)
Zinc	5.0 mg/1 (Secondary Standard)
Endrin	0.2 ug/1
Lindane	4.0 ug/1
Methoxychlor	100 ug/1
Toxaphene	5.0 ug/1
2,4-D	100 ug/1

Gas chromatography/mass spectrophotometry analyses can be performed on a highly contaminated sample to confirm the identifications of this preliminary analysis and to obtain qualitative identification of unidentified peaks. An alternative procedure to GC/MS analysis is proposed for confirmation of the organochlorine pesticides and herbicides. This procedure involves further concentration of the extracts, followed by analysis utilizing a different gas chromatograph column and detection system. This procedure is preferable to GC/MS analysis for two reasons.

1) Approximately 4 weeks would be required for GC/MS analysis at a cost of approximately $500 per sample.

2) In our recent conversation with the GC/MS lab we encountered reluctance to perform any special preparations, or analysis for compounds other than those Priority Pollutants routinely analyzed.

Since we are interested in specific types of compounds, the class - specific GC analyses will be of better use and will provide the information we need. The GC/MS lab does not perform GC/MS scans for herbicide compounds, since these are not classed as Priority Pollutants.

This proposed re-analysis procedure would be performed by Wilson Laboratories using extracts already prepared and would require less than two weeks at a cost of $150 per sample. Identified Priority Pollutants will be confirmed. Unidentified peaks of significance would be tentatively identified by published GC retention data followed by analyses of the actual compound under identical conditions as the samples.

A write-up of procedures, methodology and experimental retionale will be provided to you for use in your report with the confirmatory analyses reports.

WILSON LABORATORIES

Clifford J. Baker

Clifford J. Baker
Chemist

jh

WILSON LABORATORIES
ANALYTICAL & RESEARCH CHEMISTS & BIOLOGISTS
A DIVISION OF WILSON & COMPANY, ENGINEERS & ARCHITECTS

528 NORTH NINTH • SALINA, KANSAS 67401 • LAB: (913) 825-7186 OFFICE: (913) 827-0433

26 March 1981

Woodward-Clyde Consultants
Attn: Dr. J. D. Campbell
5055 Antioch Road
Overland Park, KS 66203

Re: Wilson Laboratories File No. 81-9521

Dear Dr. Campbell:

Wilson Laboratories has completed confirmatory analyses of selected Chevron samples for pesticides and herbicides. The analytical procedures and rationale for the procedures is discussed below.

Organochlorine Pesticides Analyses

The samples were analyzed in accordance with EPA Method 608, Organochlorine Pesticides and PCB's published in the Federal Register, Volume 44, No. 233, Monday, 23 December 1979. This procedure involves successive extractions of 1 liter of sample at neutral pH, with dichloromethane followed by concentration of the dichloromethane, solvent exchange to hexane and re-concentration to a final volume of 10 ml. The hexane extract is then analyzed by packed column gas chromatography with electron capture detection.

The electron capture detector is a highly sensitive detector, responding to picograms of halogenated pesticides. However, it is also highly sensitive to compounds such as phthalate esters and nitroaromatics which do not contain halogens and, therefore, is not selective. Because of this lack of selectivity the extracts from OWC-12, 13 and 14 were re-concentrated to a final volume of 1.0 ml and analyzed by capillary gas chromatography with Hall electrolytic conductivity detection. This system was utilized for two reasons:

1) Capillary chromatography provides greater resolving power than packed column chromatography enabling the separation of more sample components and consequently reducing the number of potential interferences.

2) The electrolytic conductivity detector operated in the halogen mode is highly selective, responding only to halogenated compounds, but lacks the sensitivity of the electron capture detector. Due to the lower sensitivity the extracts were concentrated to 1.0 ml.

- continued -

Compounds detected by both procedures provides strong evidence that the peaks detected and quantitated in the initial analyses have been correctly identified. Results of the confirmatory analyses of the organochlorine pesticides are outlined below:

1) All pesticides reported for OWC-12 have been confirmed. All pesticides except DDE and DDD have been confirmed for OWC-13. Since the confirmatory procedure detection limit is approximately 5 ug/l the pesticides in OWC-14 could not be confirmed.

2) The alpha and delta isomers of BHC were identified during the confirmatory analyses. These isomers were not quantitated, however, comparison with standards indicates that the concentrations are greater than 50 ug/l in OWC-12 and OWC-13.

3) Kelthane was not previously analyzed because it did not elute properly from the gas chromatograph. Kelthane did elute properly from the confirmatory system and was not detected in the three samples at a detection limit of 5 ug/l.

4) The major components in the samples have been identified. Several small peaks were detected in OWC-12 and OWC-13 but not identified since they represent relatively low levels of contamination.

Phenoxy-Acid Herbicides Analyses

The samples were analyzed in accordance with "Method for Chlorinated Phenoxy Acid Herbicides in Industrial Effluents" published in the Federal Register, Vol. 38, No. 75, Pt. II. This procedure involves extraction of the phenoxy acids from acidified water with diethyl ether followed by hydrolysis of the esters to acids. The extract is then solvent washed to remove pesticide interferences. The acids are then re-extracted into an organic solvent and converted to methyl esters. The extract is cleaned up by passing it through a micro-adsorption column and analyzed by gas chromatography with electron capture detection.

For reasons outlined in the section discussing organochlorine pesticides two herbicide extracts, OWC-8 and OWC-11 were confirmed by capillary gas chromatography analyses with Hall electrolytic conductivity detection. The results are outlined below:

1) The herbicides 2,4-D and 2,4,5-T were confirmed in both samples.

2) Silvex (2,4,5-TP) has been identified as a significant component in both samples. A quantitative standard was not available to determine approximate concentrations in the samples.

3) Two peaks of significance were detected but not identified. Further research and analyses would be necessary to identify the peaks.

- continued -

TABLE F-9
CHEMICAL ANALYSES

Observation Well: OWC - 10

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-26-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-24-81

Time Sampled: 14:15

STANDARD CHEMICAL WATER ANALYSIS

DATE: 13 MARCH 1981

LABORATORY FILE NO.: 81-9521
LABORATORY NO.: 8102-703C
SAMPLE RECEIVED 26 FEBRUARY 1981

CATIONS			LABORATORY ANALYSIS
CALCIUM	CA+2	MG/L	83.00
IRON	FE+2	MG/L	2.43
MAGNESIUM	MG+2	MG/L	24.00
MANGANESE	MN+2	MG/L	3.00
POTASSIUM	K +1	MG/L	2.60
SODIUM	NA+1	MG/L	82.00
ANIONS			
BICARBONATE	HCO3-1	MG/L	323.04
CARBONATE	CO3 -2	MG/L	0.13
CHLORIDE	CL -1	MG/L	112.00
FLUORIDE	F -1	MG/L	0.20
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	0.00
PHOSPHATE	PO4 -3	MG/L	0.46
SULFATE	SO4 -2	MG/L	115.00
SILICATE	SIO4-4	MG/L	0.03
SILICA		SIO2 MG/L	34.24
TOTAL FREE CARBON DIOXIDE		CO2 MG/L	269.57
EQUILIBRIUM CARBON DIOXIDE		CO2 MG/L	44.81
TOTAL DISSOLVED SOLIDS (CALC)			MG/L 776.84
TOTAL ALKALINITY		AS CACO3 MG/L	264.93
CALCIUM ALKALINITY		AS CACO3 MG/L	207.50
MAGNESIUM ALKALINITY		AS CACO3 MG/L	57.43
SODIUM ALKALINITY		AS CACO3 MG/L	0.00
TOTAL HARDNESS		AS CACO3 MG/L	305.80
CALCIUM HARDNESS		AS CACO3 MG/L	207.50
MAGNESIUM HARDNESS		AS CACO3 MG/L	98.64
NON-CARBONATE HARDNESS		AS CACO3 MG/L	40.86
CALCIUM NON-CARBONATE HARDNESS			MG/L 0.00
MAGNESIUM NON-CARBONATE HARDNESS			MG/L 41.21
PH		PH UNITS	6.62
EQUILIBRIUM PH (PHS)		PH UNITS	7.24
STABILITY INDEX		PH UNITS	7.85
SATURATION INDEX		PH UNITS	-0.62
TEMPERATURE	DEGREES FAHRENHEIT		68.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM		1080.00
IONIC STRENGTH (MOLAR)			0.0148
ION BALANCE ERROR (PERCENT) BY CONCENTRATION			-4.48

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-9
CHEMICAL ANALYSES

Observation Well: OWC - 10

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-26-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-24-81

Time Sampled: 14:15

STANDARD CHEMICAL WATER ANALYSIS

DATE: 13 MARCH 1981

LABORATORY FILE NO.: 81-9521
LABORATORY NO.: 8102-703C
SAMPLE RECEIVED 26 FEBRUARY 1981

CATIONS			LABORATORY ANALYSIS
CALCIUM	CA+2	MG/L	83.00
IRON	FE+2	MG/L	2.43
MAGNESIUM	MG+2	MG/L	24.00
MANGANESE	MN+2	MG/L	3.00
POTASSIUM	K +1	MG/L	2.60
SODIUM	NA+1	MG/L	82.00
ANIONS			
BICARBONATE	HCO3-1	MG/L	323.04
CARBONATE	CO3 -2	MG/L	0.13
CHLORIDE	CL -1	MG/L	112.00
FLUORIDE	F -1	MG/L	0.20
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	0.00
PHOSPHATE	PO4 -3	MG/L	0.46
SULFATE	SO4 -2	MG/L	115.00
SILICATE	SIO4-4	MG/L	0.03
SILICA		SIO2 MG/L	34.24
TOTAL FREE CARBON DIOXIDE		CO2 MG/L	269.57
EQUILIBRIUM CARBON DIOXIDE		CO2 MG/L	44.81
TOTAL DISSOLVED SOLIDS (CALC)			MG/L 776.84
TOTAL ALKALINITY	AS	CACO3 MG/L	264.93
CALCIUM ALKALINITY	AS	CACO3 MG/L	207.50
MAGNESIUM ALKALINITY	AS	CACO3 MG/L	57.43
SODIUM ALKALINITY	AS	CACO3 MG/L	0.00
TOTAL HARDNESS	AS	CACO3 MG/L	305.80
CALCIUM HARDNESS	AS	CACO3 MG/L	207.50
MAGNESIUM HARDNESS	AS	CACO3 MG/L	98.64
NON-CARBONATE HARDNESS	AS	CACO3 MG/L	40.86
CALCIUM NON-CARBONATE HARDNESS			MG/L 0.00
MAGNESIUM NON-CARBONATE HARDNESS			MG/L 41.21
PH		PH UNITS	6.62
EQUILIBRIUM PH (PHS)		PH UNITS	7.24
STABILITY INDEX		PH UNITS	7.85
SATURATION INDEX		PH UNITS	-0.62
TEMPERATURE	DEGREES	FAHRENHEIT	68.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM		1080.00
IONIC STRENGTH (MOLAR)			0.0148
ION BALANCE ERROR (PERCENT) BY CONCENTRATION			-4.48

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-10
CHEMICAL ANALYSES

Observation Well: OWC - 11

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-26-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-24-81

Time Sampled: 15:30

ANALYSIS	CONCENTRATION	UNITS	ANALYST	BOOK/PAGE
LAB NUMBER: 8102-0704A SAMPLE DESCRIPTION: OWC-11 CHEVRON SPECIAL INSTRUCTIONS: FILTER GLASS FIBER				
DATE SAMPLED	2/24/81			/
TIME SAMPLED	15:30			/
ALDRIN	ND(0.12)	UG/L	CJB	132 / 21
CHLORDANE	ND(1.0)	UG/L	CJB	132 / 21
4,4-DDD	1.46	UG/L	CJB	132 / 21
4,4-DDE	ND(0.20)	UG/L	CJB	132 / 21
4,4-DDT	1.46	UG/L	CJB	132 / 21
DIELDRIN	17.3	UG/L	CJB	132 / 21
ENDRIN	0.55	UG/L	CJB	132 / 21
HEPTACHLOR	ND(0.10)	UG/L	CJB	132 / 21
MALATHION	5.7	UG/L	CJB	132 / 23
SEVIN	NOT ANAL.	UG/L	CJB	132 / 21
2,4,5-T	18.8	UG/L	CJB	132 / 22
TOXAPHENE	ND(10.0)	UG/L	CJB	132 / 21
PCB	ND(10.0)	UG/L	CJB	132 / 21
LINDANE	106	UG/L	CJB	132 / 21
METHOXYCHLOR	ND(0.8)	UG/L	CJB	132 / 21
2,4-D	2300	UG/L	CJB	132 / 21
MIREX	ND(0.5)	UG/L	CJB	132 / 21
CAPTAN	ND(0.20)	UG/L	CJB	132 / 21
DIFOLATAN	ND(20)	UG/L	CJB	132 / 21
CHLOROBENZILATE	ND(0.30)	UG/L	CJB	132 / 21
GUTHION	ND(100)	UG/L	CJB	132 / 23
DIAZINON	11.1	UG/L	CJB	132 / 23
PARATHION, METHYL	2.5	UG/L	CJB	132 / 23
PARATHION, ETHYL	ND(0.5)	UG/L	CJB	132 / 23
TRITHION	NOT ANAL.	UG/L	CJB	132 / 21
PHOSDRIN (MEVINPHOS)	ND(2.0)	UG/L	CJB	132 / 23
--CONCLUSION--LAB NUMBER: 8102-0704A				
LAB NUMBER: 8102-0704B SAMPLE DESCRIPTION: OWC-11 CHEVRON SPECIAL INSTRUCTIONS: FILTERED IN FIELD				
ARSENIC	0.11	MG/L	BTF	131 / 51
CADMIUM	0.0010	MG/L	RCR	130 / 196
COPPER	0.0034	MG/L	RCR	130 / 200
ZINC	0.061	MG/L	RCR	130 / 192
--CONCLUSION--LAB NUMBER: 8102-0704B				
LAB NUMBER: 8102-0704C SAMPLE DESCRIPTION: OWC-11 CHEVRON SPECIAL INSTRUCTIONS: NO PREP				
ALKALINITY, TOTAL	170	MG/L, AS CACO3	BLD	47 / 91
CALCIUM, BY EDTA TITRATION	130	MG/L	CJA	82 / 32
CHLORIDE	264	MG/L	BLD	108 / 35
FLUORIDE	0.165	MG/L	CJA	25 / 94
IRON, TOTAL	0.11	MG/L	RCR	130 / 186
MAGNESIUM	47	MG/L	RCR	130 / 190
MANGANESE	2.17	MG/L	RCR	130 / 186
NITRATE	0.4	MG/L AS N	CJA	109 / 32
ORTHOPHOSPHATE	0.10	MG/L AS P	BLD	128 / 9
PH	6.50		LKN	83 / 76
POTASSIUM	2.3	MG/L	RCR	130 / 188
SILICON	16	MG/L	RCR	130 / 190
SODIUM	65	MG/L	RCR	130 / 188
SPECIFIC CONDUCTANCE	1540	UMHOS/CM	MJB	124 / 11
SULFATE	125	MG/L	BLD	95 / 38
TOTAL ORGANIC CARBON	~~2.6~~ 14	MG/L	GMD	85 / 69
--CONCLUSION--LAB NUMBER: 8102-0704C				

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-10
CHEMICAL ANALYSES

Observation Well: OWC - 11

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-26-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-24-81

Time Sampled: 15:30

STANDARD CHEMICAL WATER ANALYSIS

DATE: 13 MARCH 1981

LABORATORY FILE NO.: 81-9521
LABORATORY NO.: 8102-0704C
SAMPLE RECEIVED 26 FEBRUARY 1981

CATIONS			LABORATORY ANALYSIS
CALCIUM	CA+2	MG/L	130.00
IRON	FE+2	MG/L	0.11
MAGNESIUM	MG+2	MG/L	47.00
MANGANESE	MN+2	MG/L	2.17
POTASSIUM	K +1	MG/L	2.30
SODIUM	NA+1	MG/L	65.00
ANIONS			
BICARBONATE	HCO3-1	MG/L	207.25
CARBONATE	CO3 -2	MG/L	0.07
CHLORIDE	CL -1	MG/L	264.00
FLUORIDE	F -1	MG/L	0.17
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	1.77
PHOSPHATE	PO4 -3	MG/L	0.31
SULFATE	SO4 -2	MG/L	125.00
SILICATE	SIO4-4	MG/L	0.02
SILICA		SIO2 MG/L	34.24
TOTAL FREE CARBON DIOXIDE		CO2 MG/L	236.89
EQUILIBRIUM CARBON DIOXIDE		CO2 MG/L	27.56
TOTAL DISSOLVED SOLIDS (CALC)		MG/L	876.01
TOTAL ALKALINITY	AS	CACO3 MG/L	169.94
CALCIUM ALKALINITY	AS	CACO3 MG/L	169.94
MAGNESIUM ALKALINITY	AS	CACO3 MG/L	0.00
SODIUM ALKALINITY	AS	CACO3 MG/L	0.00
TOTAL HARDNESS	AS	CACO3 MG/L	517.66
CALCIUM HARDNESS	AS	CACO3 MG/L	325.00
MAGNESIUM HARDNESS	AS	CACO3 MG/L	193.17
NON-CARBONATE HARDNESS	AS	CACO3 MG/L	347.72
CALCIUM NON CARBONATE HARDNESS		MG/L	155.06
MAGNESIUM NON-CARBONATE HARDNESS		MG/L	193.17
PH	PH	UNITS	6.50
EQUILIBRIUM PH (PHS)	PH	UNITS	7.25
STABILITY INDEX	PH	UNITS	8.00
SATURATION INDEX	PH	UNITS	-0.75
TEMPERATURE	DEGREES	FAHRENHEIT	68.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM		1540.00
IONIC STRENGTH (MOLAR)			0.0199
ION BALANCE ERROR (PERCENT) BY CONCENTRATION			-0.65

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-11
CHEMICAL ANALYSES

Observation Well: OWC - 12

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-27-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-26-81

Time Sampled: 11:45

ANALYSIS	CONCENTRATION	UNITS	ANALYST	BOOK/PAGE
LAB NUMBER: 8102-0783A SAMPLE DESCRIPTION: OWC-12 SPECIAL INSTRUCTIONS: NO PREP				
DATE SAMPLED	2/26/81			/
TIME SAMPLED	1145			/
ALKALINITY, TOTAL		MG/L, AS CACO3		/
CALCIUM, BY EDTA TITRATION	88	MG/L	CJA	82 / 32
CHLORIDE	20	MG/L	~~BLD~~	~~108 / 35~~
FLUORIDE	0.34	MG/L	CJA	25 / 94
IRON, TOTAL		MG/L		/
MAGNESIUM		MG/L		/
MANGANESE		MG/L		/
NITRATE	0.3	MG/L AS N	CJA	109 / 32
ORTHOPHOSPHATE	0.05	~~MG/L AS P~~	~~BLD~~	~~128 / 9~~
PH	7.20		LKN	83 / 78
POTASSIUM		MG/L		/
SILICON		MG/L		/
SODIUM		MG/L		/
SPECIFIC CONDUCTANCE	859	UMHOS/CM	MJB	124 / 11
SULFATE		MG/L		/
TOTAL ORGANIC CARBON	5.5	MG/L	GMD	85 / 69
--CONCLUSION--LAB NUMBER: 8102-0783A				
LAB NUMBER: 8102-0783B SAMPLE DESCRIPTION: OWC-12 SPECIAL INSTRUCTIONS: FILTER GLASS FIBER				
ALDRIN	17.7	UG/L	CJB	132 / 21
CHLORDANE	ND(1.0)	UG/L	CJB	132 / 21
4,4-DDD	ND(0.20)	UG/L	CJB	132 / 21
4,4-DDE	ND(0.20)	UG/L	CJB	132 / 21
4,4-DDT	4.8	UG/L	CJB	132 / 21
DIELDRIN	7.8	UG/L	CJB	132 / 21
ENDRIN	4.3	UG/L	CJB	132 / 21
HEPTACHLOR	ND(0.10)	UG/L	CJB	132 / 21
MALATHION	223	UG/L	CJB	132 / 23
SEVIN	NOT ANAL.	UG/L	CJB	132 / 21
2,4,5-T	1.2	UG/L	CJB	132 / 22
TOXAPHENE	ND(10.0)	UG/L	CJB	132 / 21
PCB	ND(10.0)	UG/L	CJB	132 / 21
LINDANE	417	UG/L	CJB	132 / 21
METHOXYCHLOR	ND(0.8)	UG/L	CJB	132 / 21
2,4-D	ND(1.0)	UG/L	CJB	132 / 21
MIREX	ND(0.5)	UG/L	CJB	132 / 21
CAPTAN	ND(0.20)	UG/L	CJB	132 / 21
DIFOLATAN	ND(20)	UG/L	CJB	132 / 21
CHLOROBENZILATE	ND(0.30)	UG/L	CJB	132 / 21
GUTHION	ND(100)	UG/L	CJB	132 / 23
DIAZINON	4.3	UG/L	CJB	132 / 23
PARATHION, METHYL	10.9	UG/L	CJB	132 / 23
PARATHION, ETHYL	53.2	UG/L	CJB	132 / 23
TRITHION	NOT ANAL.	UG/L	CJB	132 / 21
PHOSDRIN (MEVINPHOS)	ND(2.0)	UG/L	CJB	132 / 23
--CONCLUSION--LAB NUMBER: 8102-0783B				
LAB NUMBER: 8102-0783C SAMPLE DESCRIPTION: OWC-12 SPECIAL INSTRUCTIONS: FILTERED IN FIELD				
ARSENIC	ND(0.001)	MG/L	BTF	131 / 54
CADMIUM	0.0010	MG/L	BTF	131 / 57
COPPER	0.0055	MG/L	BTF	131 / 56
ZINC	0.03	MG/L	BTF	131 / 53
--CONCLUSION--LAB NUMBER: 8102-0783C				

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-11
CHEMICAL ANALYSES

Observation Well: OWC - 12

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-27-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-26-81

Time Sampled: 11:45

STANDARD CHEMICAL WATER ANALYSIS

DATE: 03/12/81

LABORATORY FILE NO.: 81-9521
LABORATORY NO.: 8102-0783A
SAMPLE RECEIVED 02/27/81

			LABORATORY ANALYSIS
CATIONS			
CALCIUM	CA+2	MG/L	88.00
IRON	FE+2	MG/L	0.12
MAGNESIUM	MG+2	MG/L	17.70
MANGANESE	MN+2	MG/L	0.10
POTASSIUM	K +1	MG/L	2.40
SODIUM	NA+1	MG/L	36.00
ANIONS			
BICARBONATE	HCO3-1	MG/L	322.24
CARBONATE	CO3 -2	MG/L	0.46
CHLORIDE	CL -1	MG/L	20.00
FLUORIDE	F -1	MG/L	0.34
HYDROXIDE	OH -1	MG/L	0.00
NITRATE	NO3 -1	MG/L	1.33
PHOSPHATE	PO4 -3	MG/L	0.15
SULFATE	SO4 -2	MG/L	125.00
SILICATE	SIO4-4	MG/L	0.09
SILICA	SIO2	MG/L	25.68
TOTAL FREE CARBON DIOXIDE	CO2	MG/L	69.26
EQUILIBRIUM CARBON DIOXIDE	CO2	MG/L	48.79
TOTAL DISSOLVED SOLIDS (CALC)		MG/L	634.33
TOTAL ALKALINITY	AS CACO3	MG/L	264.84
CALCIUM ALKALINITY	AS CACO3	MG/L	220.00
MAGNESIUM ALKALINITY	AS CACO3	MG/L	44.84
SODIUM ALKALINITY	AS CACO3	MG/L	0.00
TOTAL HARDNESS	AS CACO3	MG/L	292.36
CALCIUM HARDNESS	AS CACO3	MG/L	220.00
MAGNESIUM HARDNESS	AS CACO3	MG/L	72.75
NON-CARBONATE HARDNESS	AS CACO3	MG/L	27.52
CALCIUM NON-CARBONATE HARDNESS		MG/L	0.00
MAGNESIUM NON-CARBONATE HARDNESS		MG/L	27.90
PH	PH	UNITS	7.20
EQUILIBRIUM PH (PHS)	PH	UNITS	7.20
STABILITY INDEX	PH	UNITS	7.21
SATURATION INDEX	PH	UNITS	0.00
TEMPERATURE	DEGREES	FAHRENHEIT	68.00
CONDUCTIVITY, MEASURED	MICROMHOS/CM		859.00
IONIC STRENGTH (MOLAR)			0.0122
ION BALANCE ERROR (PERCENT) BY CONCENTRATION			-6.42

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

TABLE F-12
CHEMICAL ANALYSES

Observation Well: OWC - 13

Ortho Chevron Chemical Company Plant
Analyzed by Wilson Laboratories
Salina, Kansas
File No. 81-9521
Date Received: 2-27-81

Sampled by:
Woodward-Clyde Consultants
PS, PB, CH
Date Sampled: 2-25-81

Time Sampled: 13:00

ANALYSIS	CONCENTRATION	UNITS	ANALYST	BOOK/PAGE
LAB NUMBER: 8102-0784A SAMPLE DESCRIPTION: OWC-13 SPECIAL INSTRUCTIONS: NO PREP				
DATE SAMPLED	2/25/81			/
TIME SAMPLED	1300			/
ALKALINITY, TOTAL		MG/L, AS CACO3	/	
CALCIUM, BY EDTA TITRATION	161	MG/L	CJA	82 / 32
CHLORIDE	232	MG/L	BLD	108 / 35
FLUORIDE	0.145	MG/L	CJA	25 / 94
IRON, TOTAL		MG/L	/	
MAGNESIUM		MG/L	/	
MANGANESE		MG/L	/	
NITRATE	ND(0.1)	MG/L AS N	CJA	109 / 32
ORTHOPHOSPHATE	ND(0.05)	MG/L AS P	BLD	128 / 9
PH	6.35		LKN	83 / 78
POTASSIUM		MG/L	/	
SILICON		MG/L	/	
SODIUM		MG/L	/	
SPECIFIC CONDUCTANCE	1560	UMHOS/CM	MJB	124 / 11
SULFATE		MG/L	/	
TOTAL ORGANIC CARBON	7.8	MG/L	GMD	85 / 69
--CONCLUSION--LAB NUMBER: 8102-0784A				
LAB NUMBER: 8102-0784B SAMPLE DESCRIPTION: OWC-13 SPECIAL INSTRUCTIONS: FILTER GLASS FIBER				
ALDRIN	16.3	UG/L	CJB	132 / 21
CHLORDANE	ND(1.0)	UG/L	CJB	132 / 21
4,4-DDD	0.30	UG/L	CJB	132 / 21
4,4-DDE	0.35	UG/L	CJB	132 / 21
4,4-DDT	ND(0.30)	UG/L	CJB	132 / 21
DIELDRIN	1.06	UG/L	CJB	132 / 21
ENDRIN	ND(0.40)	UG/L	DKS	132 / 21
HEPTACHLOR	ND(0.10)	UG/L	CJB	132 / 21
MALATHION	ND(2.0)	UG/L	CJB	132 / 23
SEVIN	NOT ANAL.	UG/L	CJB	132 / 21
2,4,5-T	0.8	UG/L	CJB	132 / 22
TOXAPHENE	ND(10.0)	UG/L	CJB	132 / 21
PCB	ND(10.0)	UG/L	CJB	132 / 21
LINDANE	2300	UG/L	CJB	132 / 21
METHOXYCHLOR	ND(0.8)	UG/L	CJB	132 / 21
2,4-D	1.3	UG/L	CJB	132 / 21
MIREX	ND(0.5)	UG/L	CJB	132 / 21
CAPTAN	ND(0.20)	UG/L	CJB	132 / 21
DIFOLATAN	ND(20)	UG/L	CJB	132 / 21
CHLOROBENZILATE	ND(0.30)	UG/L	CJB	132 / 21
GUTHION	ND(100)	UG/L	CJB	132 / 23
DIAZINON	ND(0.5)	UG/L	CJB	132 / 23
PARATHION, METHYL	ND(2.0)	UG/L	CJB	132 / 23
PARATHION, ETHYL	ND(0.5)	UG/L	CJB	132 / 23
TRITHION	NOT ANAL.	UG/L	CJB	132 / 21
PHOSDRIN (MEVINPHOS)	ND(2.0)	UG/L	CJB	132 / 23
--CONCLUSION--LAB NUMBER: 8102-0784B				
LAB NUMBER: 8102-0784C SAMPLE DESCRIPTION: OWC-13 SPECIAL INSTRUCTIONS: FILTERED IN FIELD				
ARSENIC	ND(0.001)	MG/L	BTF	131 / 54
CADMIUM	0.0006	MG/L	BTF	131 / 57
COPPER	0.0032	MG/L	BTF	131 / 56
ZINC	0.05	MG/L	BTF	131 / 53
--CONCLUSION--LAB NUMBER: 8102-0784C				

* Groundwater samples for metals analysis were filtered (0.45μ membrane) and acid preserved in the field.

Organophosphorous Pesticides

The samples were prepared utilizing the same procedure described for the organochlorine pesticides. Since the highly selective flame photometric detector was used for the analyses of these compounds no confirmatory work has been performed.

It was anticipated that Sevin could be analyzed with the organophosphorous pesticides on the nitrogen/phosphorous gas chromatograph detector. However, analyses of the samples indicated that interferences were present, which precluded use of the nitrogen/phosphorous detector for the organophosphorous compounds. The samples were then analyzed with the highly selective flame photometric detector operated in the phosphorous mode. Using this mode of operation, six phosphorous containing compounds were analyzed but Sevin could not be detected because the detector is not sensitive to nitrogen containing compounds.

A standard has been ordered for Trithion but has not been received. The extracts can be re-analyzed for Trithion upon receipt of the standard, however, no unidentified peaks were observed in the analyses of the organophosphorous pesticides indicating that Trithion was not present.

WILSON LABORATORIES

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